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WORTHLESS RIFLES IN THE GERMAN ARMY.

In December last, at Berlin, a great sensation was produced on the trial, for libel, of a clergyman named Ahlwardt. It appears he had publicly declared that Messrs. Loewe & Co., the contractors for the supply of the new rifles for the German army, had foisted upon the government a lot of cheap and worthless weapons.

Ahlwardt's chief motive in exposing the matter seems to have been his hatred of Jews, among whom were numbered Messrs. Loewe & Co.

Ahlwardt's documents, besides discussing in general the defects of the Loewe rifle, said that of 939 rifles of the Loewe make used in the maneuvers around Wesel, 530 required repairing. Several were so radically defective that they were sent for examination to the government gunshops in Spandau. One especially important document is a report as to the defects of the arms at the Wesel artillery depot. This report was dated Sept. 15, 1892, several months after Ahlwardt first made his charges.

Lieut.-Col. Lange, director of the Spandau gunshops, testified in court that the report on the examination of the defective rifles had not been concluded. He had looked over the defective rifles and had found some of them faulty. They bore traces of having been battered with hammers.

The following comments are made by the New York *Sun*:

THE GERMAN ARMS SCANDAL.

The motive prompting the disclosures made by Pastor Ahlwardt with regard to the defects of the rifles furnished to the German army does not deserve the sympathy of any fair-minded man. It was avowedly in pursuance of the anti-Semitic agitation that his charges were brought against Messrs. Loewe & Co., the firm of gunmakers who obtained from the German government a contract to furnish 425,000 rifles. Yet, although the race hatred by which Ahlwardt was inflamed is so contemptible that few persons will regret his condemnation to four months' imprisonment, it is nevertheless true that the facts brought out at his trial bear witness to shocking mismanagement and corruption on the part of the German military authorities.

Whether the manufacturers supplying the guns in question were Jews or Christians is a question entirely beside the point, for all manufacturers, whatever their religious opinions, are accustomed to make all they can out of government contracts. But it is the duty of a government to see that it is not cheated in so momentous a transaction as the purchase of serviceable weapons; and military boards are organized for the purpose of subjecting the arms tendered to the most searching scrutiny and decisive tests. If, notwithstanding such precautions, defective weapons are accepted, the blame rests mainly on the shoulder of the buyer, for there is no case in which the maxim, *caveat emptor*, is more fairly applicable. This is well understood in France; the shameful deficiencies discovered in the French armament and commissariat during the war of 1870 were imputed, as they should have been, not to the purveyors, but to the trusted officers who, by accepting worthless arms and stores, exposed themselves to the charge of criminal negligence or of bribe taking. French experience has also made good the axiom that a military board which can be bribed by a contractor is capable of blackmailing him.

Dismissing as altogether irrelevant the religious opinions of Messrs. Loewe & Co., and also leaving out of view the technical grounds on which Pastor Ahlwardt was found guilty of libel, let us look at the central fact of tremendous political and military importance to Germany and Europe which was established at the trial. It was proved by official documents of which Ahlwardt had obtained possession, and which were submitted to the court, that the rifles furnished to the German soldiers were grievously defective, and that the acceptance of such imperfect or useless weapons was due to a connivance of the very officers chosen to render such a misfortune impossible. It was shown that out of some 900 rifles officially accepted and which were used on a certain occasion, a considerable fraction burst at the first discharge, while upward of 500 were so damaged that they had to be sent back to the factory for repairs. Not only was this deplorable state of things studiously concealed from the sovereign and from the people, but the military officials inculpated by Ahlwardt vehemently denied that there were any imperfections in the weapons furnished by Loewe & Co. Some of these officials were convicted of false witness by papers bearing their own signatures. The manner in which the documents fell into Ahlwardt's hands is characteristic of the spirit animating the promoters of the anti-Semitic agitation. An officer who was indebted to a Jew for borrowed money, finding it impossible to obtain further accommodation in the shape either of an additional loan or of an extension of the time of payment, determined to cast obloquy upon his creditor and the whole Jewish race; and to that end turned over to Ahlwardt some incriminating documents in his possession, after which he is said to have committed suicide.

THE WORTHLESS GERMAN ARMY RIFLES—TRIAL AT BERLIN OF THE GERMAN CLERGYMAN, AHLWARDT, WHO EXPOSED THE FRAUDS.

It is noteworthy that these papers, which testified to the corruptibility of German military boards and to the worthlessness of many of the rifles furnished to the German army, were not read in open court, and would never have been given to the world had not a copy of them been surreptitiously obtained and published in a Paris newspaper. The publication had a distinct effect on the solution of the French ministerial crisis which was then pending. The discovery that at least half of the rifles used by the German soldiers were likely to be rendered worthless at the first discharge came simultaneously with Chancellor Caprivi's declaration that a large increase of the German army was indispensable to the defense of the German empire. The obvious deduction from such revelations and admissions was that the sooner France went to war the better, and for the first time since the downfall of the Loubet cabinet it was recognized in Paris that even the Panama scandal was a matter of subordinate importance to the maintenance of a steadfast policy in the Foreign Office and War Office, and to the further-

ance of a good understanding with the Czar. There can be, indeed, no doubt that from the moment the German arms scandal suggested that the opportunity of France might be close at hand, both the Chamber of Deputies and French public opinion underwent a profound reaction as to the relative moment of the Panama question and of international relations, and recognized the paramount necessity of retaining M. Ribot and M. de Freycinet in the departments over which they had formerly presided.

On the other hand, the effect in Germany of the grave doubt thrown by the disclosures made at the Ahlwardt trial on the trustworthiness of German military boards and the efficiency of the arms furnished to German soldiers should be to strengthen the enemies of Caprivi in the Reichstag. The latter may say that no such charges were brought home to the German military authorities when Bismarck was at the head of the government, and that a radical change of officials, from the chancellor and war minister downward, should take place before additional appropriations of money are made, or any radical reconstruction of the army is attempted. The feeling that some of the present military authorities no longer deserve confidence is probably at the bottom of the popular dissatisfaction at the conviction of Ahlwardt—a dissatisfaction which found vent, while the trial was still pending, in his election to the Reichstag by an immense majority.

[Continued from SUPPLEMENT, No. 892, page 14249.]

SMOKELESS POWDER AND MAGAZINE RIFLES.*

By L. G. DUFF GRANT.

SMOKELESS POWDER COMPANY, OF LONDON.

I COME now to the smokeless powders in which I am most interested, namely, those of the Smokeless Powder Company, of London, whose manufactures, "though I say it as shouldn't," are second to none. It is, I believe, the only company in Europe, and I rather think I may add this side of the water too, that has a complete series of smokeless powders for shotguns, for rifles of all sorts, for revolvers and for mining purposes.

The company was formed early in the year 1888, but it was not until December, 1890, that their powders were first placed upon the market. The intervening time was spent in the erection of the necessary works, after a suitable site had been found for the purpose. To find a suitable site in England and obtain the necessary licenses to manufacture explosives is not an easy matter. Of 182 offered, only one was found suitable, but that one seemed specially made for us. I know of one explosive concern which took 18 months to find a site which the inspector of explosives would pass.

This will give you some idea of the difficulties to be overcome. In the erection of the works we were fortunate in having as our engineer a man who was well known in England as an expert in explosives, Mr. Ernest Spon, a man who had devoted, I may say, his whole life to the subject

Under his superintendence the works made rapid progress, and by July, 1890, were reported ready for occupation and for the manufacture of powder. No time was lost in setting to work, and in December of the same year the first powder smokeless S. S. was placed in the market.

Before I go on to speak of the company's various powders, I may state that they do not form the subject of any patent, and therefore I am unable to say anything as to the ingredients which are used in their manufacture. I can, however, tell you what they do not contain. There is no gun-cotton, no nitro-glycerine, I am glad to say, in any of them, and I need hardly add after what I have already stated, that there is no ammonium nitrate, no chlorate of potassium, no picric acid, in their composition. The ingredients we use are all of a thoroughly stable nature. The manufacture is carried on by secret processes which are only known to two men inside our factory. It is well for us we have no patents, which only mean that you reveal to all the world what you are doing, to say nothing of the fact that few, if any, chemical patents are really valid. It is so easy to add something and call it an improvement. As far as we are concerned, we have no apprehension of those secrets ever being found out. We know chemists in different parts of the world have been at work on them for years, but they are as far from being able to make them to-day as they were when they first started. As for the work people, nothing is to be feared from them. They see certain processes and certain ingredients used in these processes, but they have no idea what they are or what their composition is. Our works manager and our chemist, who alone know the secret, are part and parcel of ourselves, and of them I can only say, "They are beyond suspicion."

One important thing which has conduced as much as anything to the uninterrupted success which has attended the company's progress has been the fact of the board being composed of practical business men, who knew what they were about before taking the matter in hand, and that cannot be said of all companies.

First and foremost is our managing director and chairman, Mr. J. D. Dougall, of the firm of J. D. Dougall & Sons, well known as gun and rifle manufacturers in London and Glasgow. I always held that the people of this generation are wiser than their fathers (at any rate they ought to be), in so far that they have all the experience of their fathers before them to guide them, as well as all extra knowledge which they themselves may acquire, and so it was in this case. Mr. Dougall is the son of Mr. J. D. Dougall, whom I have already mentioned as having been the first to bring Schultze power to public notice.

The son who had, with his father, for many years devoted himself to the patient and laborious investigation of all subjects connected with gunpowder, on which he is an acknowledged authority, seeing that the new powders belonging to this company were a distinct advance on anything that had hitherto existed, after submitting them to the severest possible practical tests, expressed himself willing to join the board and act as technical and managing director, and to him is mainly owing the success that has attended the company. Cautious to the extreme, he never allowed a new powder to be offered to the trade until after it had undergone the most stringent tests and been found in every way up to the required standard. The fact of his being connected with the company was the best of all guarantees to the gun trade that the company's powder would be found up to the mark. The other directors are Colonel Henderson, a well-known Indian officer, than whom no one could be more competent to guide and advise the board on military matters, and Mr. M. S. Vanderbyl, a well-known merchant in London, and a man both able and willing to direct the ship in all commercial transactions.

So much for the board. Now, as regards the factory itself. It is situated about 25 miles north of London, at a pla:e known as Barwick, in the county of Herts, just an hour's run by train from London. It is within 2¼ miles from the railway station, or 5 miles from the river Lee and canal, both of which communicate with the Thames, so that transport is easy either by rail or water. It comprises 126 acres, and we have it on a 99 years' lease. The factory itself consists of some 40 different blocks of buildings, erected at the proper regulation distances. The area within which the manufacture is carried on is about 33 acres, and has been thoroughly fenced in with a six-foot ring fence. A more suitable site it would be impossible to find. Both steam and electric power are in use for driving the machinery in all the buildings.

The first powder placed on the market was the company's Smokeless S. S. sporting powder for use in shot guns. Thanks to the energy of Mr. Sampson, our agent in New York, and Mr. Patten, his manager in Boston, it is now almost as well known in the United States as in England.

S. S. having been fairly started, our next venture was Smokeless S. R., intended for use in the existing military rifles, such as the Martini-Henry, the United States government 0·45, and for sporting Express rifles, in fact for rifles of any bore from 0·360 to 0·577, and for machine guns of the same caliber.

The advantages obtained are absence of smoke, remarkable reduction in recoil, abolition of fouling, reduction of heating of the barrel, increased accuracy of shooting, reduction in the weight of the cartridge. It is the only smokeless powder, I believe, which armies who have not the magazine rifles can use, and many governments I know have no intention of adopting a magazine rifle, because they cost too much money. Experiments of an exhaustive nature have been carried out with a large number of weapons, and the results obtained are superior to any hitherto reached, increasing the effectiveness of each rifle. We have shot it in the 0·577, 0·500, 0·450, and 0·400 bore Express rifles:

Martini-Henry 0·450.
U. S. government 0·45.
French Gras 0·434.
German Mauser 0·434.
Spanish and Egyptian Rem. 0·433.
Italian Vetterli 0·420.
Swedish Jarmann.
Winchester 0·50 (300 grain bullet).
Winchester 0·45 (300 grain bullet).
Winchester 0·45 (405 grain bullet).
Winchester 0·45 (500 grain bullet).
Winchester 0·45 (350 grain bullet).
Turkish Martini Peabody 0·450.
The Springfield.
The Martin.
Belgian Comblain.
Japanese Murata 0·433.
Dutch Beaumont 0·430.
Russian Berden 0·420.

ADVANTAGES OF SMOKELESS POWDER.

The great trouble experienced with recruits in their being "gun shy," *i. e.*, afraid of the recoil and jump of their rifles, is removed by the use of this powder. It is also an enormous advantage to a cavalry force, as it enables the soldier to fire with one hand.

In order not to interfere with the sights already on existing rifles, and which are marked to agree with the muzzle velocity obtained by ordinary black gunpowder, the smokeless S. R. has been made to produce the same muzzle velocity, or, at the most, not more than 1 per cent. increase, so that existing rifles can be used with the regulation ammunition charged with S. R.

An important feature in connection with this powder, and which equally applies to all the company's products, is that it has no injurious effect upon and does not corrode the barrel of the rifle.

Not being affected by heat or damp, it is invaluable for use in any climate.

One ton (2,000 lb.) of smokeless S. R. will load as many cartridges as two to two and a half tons of black powder. For example, one ton of black powder will load 164,700 Martini-Henry cartridges, whereas one ton of smokeless S. R. will load 360,000. Or 1,000,000 Martini-Henry cartridges loaded with Smokeless S. R. will weigh three tons less than if loaded with black powder.

In the other rifles, Remington, U. S. government, 0·45 Gras, etc., the difference is still greater.

There is thus a very important saving in transport.

This powder being slow in combustion is particularly suited for use in punt or duck guns, from the greatly lessened report, the reduction of recoil, and the absence of smoke. For punt guns the load is about one-third the weight of the ordinary black powder charge.

The charge of S. R. to obtain the highest results varies in different rifles, as much depends upon the particular cartridge used, the strength of the cap, the size of the flash hole, the weight of the bullet, and the nature of the rifling. Approximately it runs from 35 to 50 per cent. of the weight of black powder.

Good cartridges, good caps and proper bullets are all very important points in conection with the use of nitro-powders. At first we had considerable trouble in getting the cartridge makers to understand that the occasional hang-fires which resulted with nitro-powder were the fault not of the powder or any particular batch of powder, but of their bad caps with weak ignition. The caps of one firm only we found to be always the same, the result being that for a time we had to throw all our orders for S. R. cartridges into their hands. This, however, did not last long, and now there is practically no difference whether Messrs. Eley, Kynoch or Joyce's cases and caps are used.

The next point is size of flash hole, also very important. In some cartridges one flash hole of fair size will be found sufficient. In others, such as the Martini-Henry, two are absolutely necessary, but this is only a matter of experiment with each particular weapon. The powder will suit any rifle of 0·360 to 0·577 bore, if these points are attended to. It is also absolutely essential that the bullet fits the rifle—that is, that it takes the rifling and is sufficiently tight to prevent the escape of gas. If there is any escape of gas between the rifling and the lead, the bullet will probably drop at the muzzle of the gun. Cromwell used to say to his men, "Say your prayers and keep your powder dry." If he lived now I think he would add, say your prayers and look to your caps and bullets.

S. R. powder has become a universal favorite in England for Express rifle shooting, and it is also being adopted by the Indian government, with whom we have at present a contract for the supply of a million rounds of ammunition. In regard to S. R., Messrs. Eley Bros. reported as far back as November, 1890: "We are obliged for yours of the 5th November, and we take note of the charge of S. R. powder that you recommend for the various military rifles. We took a target at 500 yards with the sample of powder you left us with the Martini-Henry rifle, and the result was very good indeed, the mean deviation being 5·75 in. When you have any powder suitable for the 0·303 magazine rifle, we should be glad of a sample." General Arbuthnot, proofmaster to Kynoch & Co., also wrote us about the same time: "I have to inform you that I have tried the S. R. powder in the Martini-Henry solid-drawn case and also the 'Rifleite' powder in the 0·303 case, in both cases with very satisfactory results. I find that I get the best results with 40 gr. of S. R. powder. The velocities and shooting were good with both rifles, and we are now prepared to make up M. H. or 0·303 ammunition with your smokeless powder whenever we may be asked to do so."

The next powder our chemist took in hand was smokeless S. K. specially constituted for the small bore central fire rifles, of a caliber from 0·230 to 0·380, used for rook and rabbit shooting and for gallery shooting in America, the advantages obtained, in addition to practically no smoke, being reduction of noise and absence of fouling.

Improved shooting is obtained with this powder in the Morris tube 0·279 | 0·230. It is not suitable for revolvers, for large bore rifles or for shot guns.

As regards loading, the charge is about one-half by weight of the load of ordinary black powder.

A wad must always be used and the cases properly "nipped."

To obtain good and accurate shooting these points must be carefully attended to.

SMOKELESS RIFLEITE FOR MAGAZINE GUNS.

I come now to probably the most important powder of all as far as military circles are concerned, namely, smokeless "rifleite," for the new magazine rifles of 0·303 to 0·315 bore, such as the Lee, Mannlicher, Lebel, Mauser, Berthin, etc. In England, as I have already mentioned, cordite has, owing to the influence of Sir Frederick Abel, for the time being, been taken up by the government, but from military men who know what is going on we understand that it has in many respects proved so unsatisfactory and so unreliable that it is only a matter of time for it to be discarded and "rifleite" adopted. At present it is not an uncommon thing for the men of several different regiments when they are going to shoot in any important competition to apply to us for a supply of rifleite ammunition, which they use instead of the cordite cartridges issued to them by the government. Of course, they keep that to themselves, but it proves that the shooting obtained with rifleite is much more accurate than that from cordite, or the men would have no occasion to alter.

I shall now read you the summary of a report of trials, with both rifleite and S. R., carried out at one of the government ranges in England. It runs:

200 yards range (Metford rest).—Rifleite in magazine rifle, 10 shots. Mean deviation, 69 feet; S. R. in Martini-Henry, 64 feet.

500 yards range (Metford rest).—Mark II., 0·303 magazine rifle. In lovely weather. Perfect shooting. We found the sighting 50 yards lower than given by cordite, therefore lower trajectory. The result was a mean deviation of 0·59 feet. The same result was found by a table rest with both rifleite in the 0·303 and the S. R. in the Martini, namely, 69 feet and 71 feet, respectively.

700 yards range (Metford rest).—Rifleite, in magazine rifle, mean deviation of three diagrams, 89 feet S. R. in Martini-Henry, about the same, namely, 0·87, 0·99, 0·91. Gusty wind.

1,000 yards range (from shoulder).—The shooting was extremely good. We took no diagrams, but excellent shots were employed, who were extremely pleased with their performance.

1,000 yards range.—Maxim gun, fusee spring at about 10 lb., gave excellent practice, both in regularity and accuracy. The fire was as rapid as with black powder, with much greater accuracy and uniformity. The advantages derived from absence of smoke and absence of fouling were very apparent.

2,000 yards range.—Maxim gun. The results were equally good at this range, and the beaten zone was densely covered with bullets. The ammunition particularly suits the Maxim gun.

2,500 yards range.—Some excellent collective fire was done. The bullets hit with great energy even at this range and with great regularity.

There was no fouling or smoke to compete with, and both rifles were easily cleaned.

The recoil was very much less in the Martini-Henry and practically *nil* in the Mark II., 0·303 magazine rifle.

200 *rounds were fired rapidly from both rifles without the rifle becoming too hot to use.* In this test both powders were greatly superior to cordite, and, of course, to black powder.

There is no doubt whatever about the regularity of both, and also of the *absence of unpleasant smell as found in some compounds.*

We have carried out numerous water tests with

* Reports of a lecture delivered before the United Service Club, N. Y. December 17, 1892, by L. G. Duff Grant, F.I.S., Secretary of the Smokeless Powder Co., of London.—*Army and Navy Journal.*

both powders, and find that after the water evaporates the strength is in no way diminished. We put a few packets in water for fifteen days, then took them (undried) to the range, and only one went short out of thirty rounds.

There is a deposit left behind when firing with cordite powder, and in case of a wind from the front, this deposit can be easily collected from the men's clothing. This is a great disadvantage to the men, as it gets in their eyes and faces. There is absolutely no such discharge in using either S. R. or rifleite, which are both most pleasant powders for the firer to use.

Cordite does not appear to burn properly, and at long distances you frequently find the projectile falling a long way short. Now this has not occurred in a single instance during these trials with either S. R. or rifleite. Only one round went short of thirty rounds which had been 15 days in a bucket of water and were taken straight to the range.

There is no flash at all from either powder by day or night, so there is nothing but the report to guide an enemy in his fire if he cannot see his assailant.

The water tests leave no doubt as to the keeping properties of both powders.

We have definitely found rifleite and S. R. superior in every way to any others that have been tried.

A very important point referred to in this report is that there is no flash or flame from either S. R. or rifleite.

During the experiments made at night by a certain government at 2,500 yards the following incident occurred. The markers were in the custom of inspecting the target with lanterns and marking off the shots, after which they waited to see the flash to which they were accustomed, and then made a rush under cover before the bullets came up. But on this occasion, when the fire began with rifleite and S. R. neither the firers nor the markers being aware that these powders gave no flash, the latter found the bullets pattering around them, resulting in their making a retreat for the mantlets with greater haste than usual. In fact, they had a narrow escape. The importance of this feature in these powders will be readily recognized.

The annual report for 1891 of the National Rifle Association shows that the shooting at Bisley with the smokeless S. R. powder in the Martini-Henry at 600 yards was superior to the shooting for the "Martin's" and St. George's cups, also at that distance (600 yards) with black powder, although the "crack shots" did not to any extent take part in the company's competition, being engaged in the "Queen's" and other important events. The average in the smokeless S. R. was 22·37. Black powder in the "Martin's," 22·22, and in the "St. George," 22·01. This experience again exemplifies the regularity of this powder and the influence it has and will have in the further development of rifle shooting.

From rifleite will, in due course, be developed the powder for use in artillery and large guns. It will, I expect, be a somewhat expensive matter, but it is not one of any difficulty. The only point to be settled is the size of the cubes or whatever shape is decided on for each particular size of cannon.

POWDER FOR REVOLVERS AND FOR BLASTING.

I come now to the last of our powders for small arms, namely, smokeless S. V., for use in revolvers. Of all the powders I have mentioned, it was the most difficult to hit off, and was only arrived at by our chemist after 18 months' laborious and careful experimenting. The difficulty was owing to the shortness of the barrel to obtain the necessary amount of explosive force to propel the bullet without unduly increasing the pressures. Our own army have adopted a revolver of 0·455 bore, from which excellent shooting is obtained.

Last of all comes our smokeless S. B. for blasting and mining purposes.

Of S. B. there are two varieties, S. B. 1 for hard rock and S. B. 2 for softer rock, such as coal, slate or chalk. In their effects they are more like dynamite than gunpowder, S. B. 1 being equal in strength to No. 1. dynamite, while S. B. 2 is more gentle in its action.

They are supplied in cartridges, which are packed, along with the necessary primers, in cardboard boxes, each weighing 5 lb.

The primers are small cartridges about 2 inches long. They have an extra waterproof wrapper or envelope round the upper part, to enable them to be firmly tied round the fuse, and prevent the fuse and detonator slipping from their position.

The advantages gained by use of these powders are:

They are absolutely safe to carry and handle.

They emit little flame, and produce neither noxious fumes nor smoke, so that the miner can immediately return to examine the effect of his shot, and continue work without having to wait for any fumes or smoke to pass away, thus saving time and preserving the health of the workmen.

There is a great saving in drilling, smaller and fewer bore holes being required.

In holes of the same diameter, one inch in length of S. B. is equal in effect to from three to four inches of gunpowder.

But a more important saving is effected by the reduction of the diameter of the bore holes. Thus a one inch hole charged with S. B. is much more effective than a two inch hole charged with gunpowder.

Smokeless S. B. burns very slowly, so that if accidentally fired without being detonated it would only burn, much as a flare light, without danger.

It is not affected by heat and does not freeze, which renders it peculiarly suitable for export to warm or cold climates.

For both S. B. 1 and S. B. 2 No. 6 detonators should be used. Good results can also be obtained with S. B. 1 using Nos. 3, 4, or 5 detonators, but they are not recommended where No. 6 are available.

For use under water the fuse must be tied tightly into the primer, so as to prevent the possibility of water reaching the powder or the fulminate in the detonator. At the same time care should be taken in tying the fuse not to cut or tear the wrapper of the primer.

In wet or damp ground waterproof fuse must also be used.

S. B. completes the list of the Smokeless Powder Company's products.

I may add that during the whole of the time we have been at work we have never had a single accident from explosion. The process is absolutely safe; in fact, an explosion is simply impossible until the powder gets into the drying house, the manufacture being carried on in the wet state up to that point, and even then it is highly unlikely, as we use only heated air for drying. With regard to the safety of the completed article, I had very good proof of that some little time ago. I had undertaken to revise an article for the editor of a well known English magazine, and one morning he came in to discuss some points with me. I was showing him the difference in rates of combustion of the different powders to suit different bores, and I stupidly, without noticing it, laid down a tin containing a pound of powder close beside the glass on which I was burning the powders. The result was the powder in the tin, which had no lid on, caught fire, and after it had burned for a few seconds and the gas in the tin was developed sufficiently, it burst with a loud noise, scattering the rest of the unburnt powder over the room. Had that been black powder, I fear it would have been all up with both of us, and I should have missed this pleasant trip across the Atlantic and the world would have had one editor less.

MAGAZINE RIFLES.

I come now to the subject of magazine rifles. The choice of a repeating rifle is a matter of as vital importance as the selection of a smokeless powder for it.

The gain of a magazine rifle, whether it be of large or small caliber, over a single loader, apart from the confidence that it inspires, consists in the number of rounds that can be fired continuously through the magazine. The soldier has not at a critical moment to fumble about his pouch for a cartridge. The magazine rifle has no advantage over the single loader as regards rapidity of fire, if the firing be continued for one minute, owing to the time necessary to refill the magazine after its contents have been expended. It is stated that between fifty and sixty rounds have been fired from the single loading Soper rifle in one minute, and it is very doubtful whether any magazine rifle could attain that rate of fire. . . . Moreover, unless special precautions were taken, the barrel would become terribly heated after one minute of such firing. Naturally, no aim could be taken under such conditions of rapidity.

The advantage of the magazine rifle is that a soldier, when the enemy are about to charge, can fire eight shots in rapid succession, or with deliberation, without removing his rifle from the shoulder or seeking for cartridges, which, in the excitement, he may be clumsy about seizing and placing in the breech. The magazine loader is also invaluable to a sentry against a superior body of men who attempted to rush him, and would enable a couple of men under cover to hold a bridge or any other similar short narrow defile against a company.

At the same time, in the hands of ill-disciplined, badly commanded troops, a magazine rifle "might prove a curse instead of a blessing."

It may, however, be taken for granted that the single breechloader will soon be as obsolete a weapon for military purposes as the old muzzle loader now is.

Repeating rifles were first used by soldiers in the American Civil War of 1861–64, the cavalry on both sides being provided with the Winchester and Spencer repeaters. In the Russo-Turkish war of 1877 the Turkish cavalry possessed large quantities of Winchester repeaters. In 1878 the French supplied their navy with the Kropatschek repeater. In 1885 some French battalions in Tonquin were three times repulsed by a body of Chinese who were provided with a Lee detachable magazine rifle. In the same year, at the conquest of Tunis, and again in 1885–86, in Madagascar, the French used magazine rifles.

In 1886 the Austrians adopted the Mannlicher magazine rifle, and some 80,000 were manufactured and issued to the troops. The magazine holds one packet of five cartridges.

In Denmark trials have been taking place since 1883, and it is believed that the American Lee rifle, with a caliber of 0·315 in., or the Krag-Jorgensen, will be adopted.

The French, till lately, possessed two descriptions of magazine rifles, the Kropatschek and the Gras. These being found unsatisfactory, the Lebel has finally been adopted, bored to 0·315, and some 350,000 have been issued.

The rifles adopted by the Germans are the Mauser, 0·310 bore, and also a slightly altered form of the Mannlicher.

Italy and Switzerland have taken to the Vetterli, with a bore of 0·409, while Turkey and China favor a caliber of 0·433. Switzerland has also a magazine rifle known as the Schmidt.

Sweden has adopted a Remington small bore instead of the Jarmann. In America I understand the authorities have finally decided upon a modified form of the Krag-Jorgensen.

In the English army the reduction of caliber has been carried to an extreme point, the Lee-Metford of 0·303 bore having been adopted. At first it was not looked upon with favor, as it was considered too complicated a weapon for practical use, but it has now been greatly altered and improved, and in every point comes up to the standard laid down by the committee of selection, that standard being: (1) strength to stand the rough usage of service in the field; (2) non-liability to get out of order; (3) easy extraction of cartridge case after firing; (4) lowness of trajectory; (5) accuracy; (6) ease of manufacture and repair.

The following are its chief points: The breech action is on the "bolt" system and the cocking piece is so arranged that the rifle can be carried at half cock. The barrel and rifling is as follows: Length of barrel, 30·2 in.; caliber, 0·303; rifling, Metford system with seven grooves; depth, 0·004 in.; left handed spiral, one turn in 10 in. The magazine consists of a sheet steel box, inserted from under the body in front of the trigger guard, through an opening in the body and secured from loss by a steel chain. It is held in position by a spring in the body engaging a notch on the magazine. It contains eight cartridges, and may be filled when in position in the rifle, or when detached, by inserting the cartridges one by one. A spring at the bottom of the magazine presses upward a movable platform, forcing the column of cartridges also upward. A "cut off" is fitted to the right side of the body which, when pressed inward, stops the supply of cartridges from the magazine, so that the rifle may then be used as a single loader. The magazine can be removed by pressing a small lever inside the trigger guard. The rifle is provided with two sets of sights, one set graduated up to 1,900 yards, and the other from 1,800 to 3,500 yards for extreme range firing. The bayonet is a two-edged sword bayonet. The weight of the rifle with the magazine empty is 9 lb. 8 oz., weight of sword bayonet 15¼ oz., scabbard 4¾ oz.

While reducing the bore the committee likewise decided to shorten the sword bayonet to 12 inches.

In this they probably followed the example of Frederick the Great, who, when a minister once proposed to lengthen by two inches the sabers of his cavalry, in order that they might be equal to those of the enemy, replied: "Let my soldiers approach by two inches instead, and re-establish the equilibrium in that way." All the same experiments and combats between men with bayonets of various lengths and shapes have established the superiority of a short over a long side arm.

The bullet has a lead core, with an envelope of some other metal, a purely leaden bullet being found unsuitable as, owing to the increased velocity and the rapid twist, the barrel becomes leaded after a few rounds. For the envelope copper, nickel, and steel were all tried, and the latter finally adopted. The objection to copper is that the "first shot" fired out of a clean barrel is very erratic, and the copper flies off from the lead on striking. It is possible, too, that if this bullet was used in civilized war, it would be considered as an infraction of the Geneva convention.

There can be no dispute about the numerous advantages possessed by a small bore rifle over one of a comparatively large caliber. They are these: Reduction in size and weight of cartridges, 115 rounds of the new ammunition weigh no more than 70 of the Martini-Henry; increased accuracy and penetration; practical absence of recoil; higher muzzle velocity, giving a lower trajectory, using the fixed sight, a man can be struck up to 470 yards; saving in transport of ammunition; a greater number of cartridges can be carried in the magazine of the rifle without increasing the weight of the former.

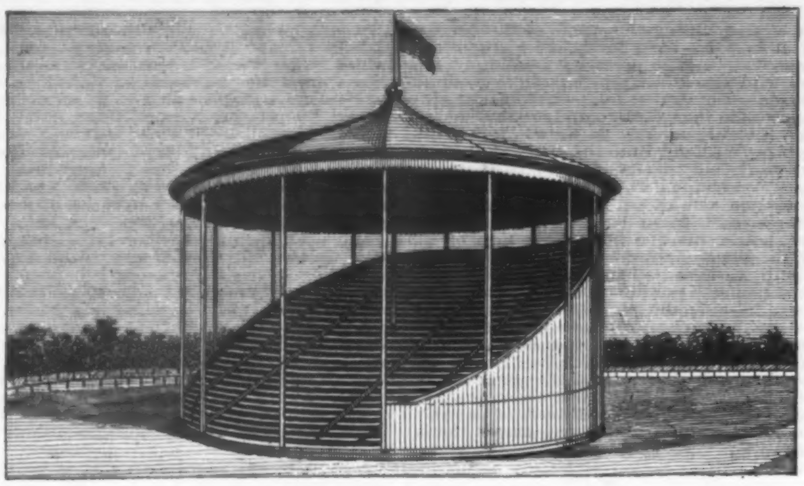
The introduction of magazine rifles and a smokeless explosive agent must be followed speedily by a revolution in tactics. For were contending forces approaching each other under the tactical conditions now in vogue, one dependent on gunpowder would suffer tremendous blows from batteries whose position and distance they would be quite unable to determine except by the sound and report, and their outposts would be completely demoralized by being harassed and picked off by an unseen enemy. Their attacking line would suffer severe losses without being able to adequately inflict them on the advancing enemy, and, lastly, when at close quarters enveloped in dense smoke from the rapid use of their own magazine rifles, their enemy, provided with the smokeless explosive, would have a perfectly clear front.

From what I have said I am sure you will all agree with me that the days of black powder are numbered, and that the adoption of smokeless or nitro powders and magazine rifles for all military purposes is only a matter of time. No doubt there are occasions during naval and military operations when the shroud of smoke produced by musketry or artillery fire has proved of important advantage to one or other or to both of the belligerents, but this smoke will have to be found from other sources.

Invention begets invention. The latest is that Colonel Crease has invented a sort of fuse or rocket case which, on ignition, gives forth dense volumes of smoke, with the idea of effecting a screen for the attack. Also from Berlin we learn that Professor Scheiller has improved upon Colonel Crease's fuses by inventing a machine for producing artificial smoke on a battle field to counteract the introduction of smokeless powder, and the French have a new invention in the shape of a smoke bomb intended to be fired into the ranks of the enemy who uses smokeless powder, and so obscure their view.

With the adoption of smokeless powder the duties of the guard and patrol will be made immeasurably more difficult by the absence of smoke and noise, which in the case of the employment of ordinary powder attracted the attention to and pointed out the position of the enemy. On the other hand it will render capital service to the franctireurs whose object is to escape from and confuse the guard.

Sudden attacks and surprises will become matters of such daily occurrence that outposts and patrols will have to be immensely strengthened and kept at the utmost tension of watchfulness. Firing drill and discipline must necessarily be made much stricter than at present. The most important fault of the smokeless powder is, however, the terrible clearness, the overwhelming distinctness with which, when it is used in battle, every man will be able to see the carnage and slaughter around him. Hitherto the heavy roll of the firing has mercifully smothered the cries and shrieks of the wounded, the cloud of powder smoke has veiled the horrible sight of men piled in heaps dying and dead, their dreadful sufferings, their agonized end. Each man fighting behind a thick fog of smoke, which was only wafted aside now and then by a gust of wind, or lightened by a pause in the firing, felt a certain sense of screened security, mistaken indeed, but none the less reassuring, until he himself was struck by the fatal bullet. How will it be in the future? The fall of each man who is shot down will be clearly seen by his comrades, every cry of anguish will be heard by half the company, the least hesitation, the least vacillation, which, through the rapid change of commander, that a death or a severe wound often renders necessary, will be immediately observed by the men and rob them of that feeling of perfect confidence they ought to have in their officers. On the other hand, the advantages of smokeless powder may be summed up: The demoralizing and bewildering effect on the corps exposed to infantry fire, and the difficulty experienced by the enemy in determining the distance



REVOLVING GRAND STAND—CROSS SECTION OF BASE.

and the direction whence the fire comes, the increased certainty of aim arising from the absence of smoke from their own fire, especially in the case of artillery, where it enables at least three times as much to be fired as with the old powder. For the defense, it is an inestimable boom; for the attack, it means certain death.

REVOLVING GRAND STAND.

We here illustrate the revolving grand stand of P. P. Cuplin, West Bend, Iowa. It floats upon water contained in a shallow basin. This allows it to be easily turned as the race progresses, thus keeping the track always in view. The above diagram represents a cross section of the base of the revolving grand stand. C represents a shallow basin made in the ground, about 2½ feet deep; B, water contained in the basin; A, water-tight bottom of stand floating, held in place by the post, D. The friction is almost entirely overcome, although the weight sustained may be several thousand tons. The stand when crowded to its full capacity sinks into the basin about 14 inches if composed of one section and about 20 inches when composed of two sections one above the other.

There is scarcely a limit in size and seating capacity; a stand with 50,000 chairs is just as practical as one that seats 5,000 people. As the base is correspondingly large, the stand does not sink into the water any deeper. The power necessary to revolve the stand in the required time for mile tracks is one horse power for every 250 people. The cost of constructing a revolving stand is about 50 per cent. more than the ordinary stand.

IMPROVED ROCK DRILL AND AIR COMPRESSOR.

This is the invention of Mr. James McCulloch, of Wolverhampton.

Fig. 1 shows the machine mounted on the end of a special tripod for drilling close to the wall, while at Fig. 2 we give a longitudinal section, showing the detail arrangements. Fig. 3 represents Mr. McCulloch's tunnel car mounted with four 3¼ inch Rio Tinto drills.

Turning to the advantages of the drill, we may observe that the first one claimed—positive valve motion—is obtained by the combined action of the air pressure and a tappet actuated by the piston rod itself, which imparts a definite and positive movement to the valve at each stroke. Where the valves are operated by the pressure of air alone, it has been found unreliable, and is rendered inoperative by the entrance of dirt, grit, or rust. Tappets and tappet valves are also employed, in some cases in conjunction with springs, at the back of the valve, to retain it in position during the time it is not being acted upon by the piston. The failure of the springs to fulfill their function, owing to excessive friction, weakness, or breakage, is often the cause of stoppages, loss of time, and expense, which are entirely avoided by Mr. McCulloch's valve motion. With respect to the second advantage we may observe that the importance of a reliable and durable twist gear cannot be overestimated. An ineffective or partially disabled gear will quickly reduce the effective or actual work of a drill to a minimum, and, when in the hands of unskilled men, much loss is caused by drills being kept at work in a partially disabled condition. Ratchet wheels, with internal or external teeth, held by pawls and springs, have been hitherto employed in rock drills. These form a chief source of trouble and expense through the constant breakage of the ratchet teeth, pawls, and springs, which are subject to frequent and violent concussion when the drill is at work, sometimes causing the fracture of the twist bar itself. The rotation of the drill is thus either interrupted or entirely arrested. The "star" twist gear now introduced in the Rio Tinto drill is an entirely new departure from the above methods. All ratchet wheels, pawls, and springs are done away with. It is unique in simplicity, durability, and certainty of action, no matter what the nature of the rock may be, how fast or slow the drill is running, or how long or short its stroke. The rotation is always precise and accurate, and no injury can be done to either gear or twister, both being relieved of the concussion and friction which other gears are subjected to.

Turning to the third advantage as to the cradle, it is to be observed that in some cases the cradles of rock drills have no provision made for taking up the wear and keeping the machine steady when at work. Attempts to effect this have, however, been made in some instances, but the necessity of removing the drill from its work and the employment of skilled labor in order to adjust it reduce the value of the result to a minimum. In the case of the Rio Tinto drill, the cradle can be easily and quickly adjusted while the drill is at work, no skilled labor or fitting being required. In order to enhance the durability of the machine, the highest class of design, workmanship and materials are employed throughout. Experience has shown that this increases the life and maintains the boring power considerably beyond those of inferior and cheaper manufacture. Generally we may observe that the constant renewals and fitting of moving parts is now greatly obviated by the recent improvements and self-adjustment of them in working. The entire absence of all springs, combined with the foregoing advantages, are features which recommend themselves at once, and are in fact being fully recognized. The improved mountings, of which there are others besides those illustrated by us, are the result of twenty-two years' experience which Mr. McCulloch has had in the performance of all classes of mining and quarry work, and they are found to facilitate the handling of the drills and economize time and labor to a remarkable degree. The proved superiority of the Rio Tinto rock drill, under all conditions, is confirmed by testimonials from a number of practical users, based on their own observation and experience.—*Iron.*

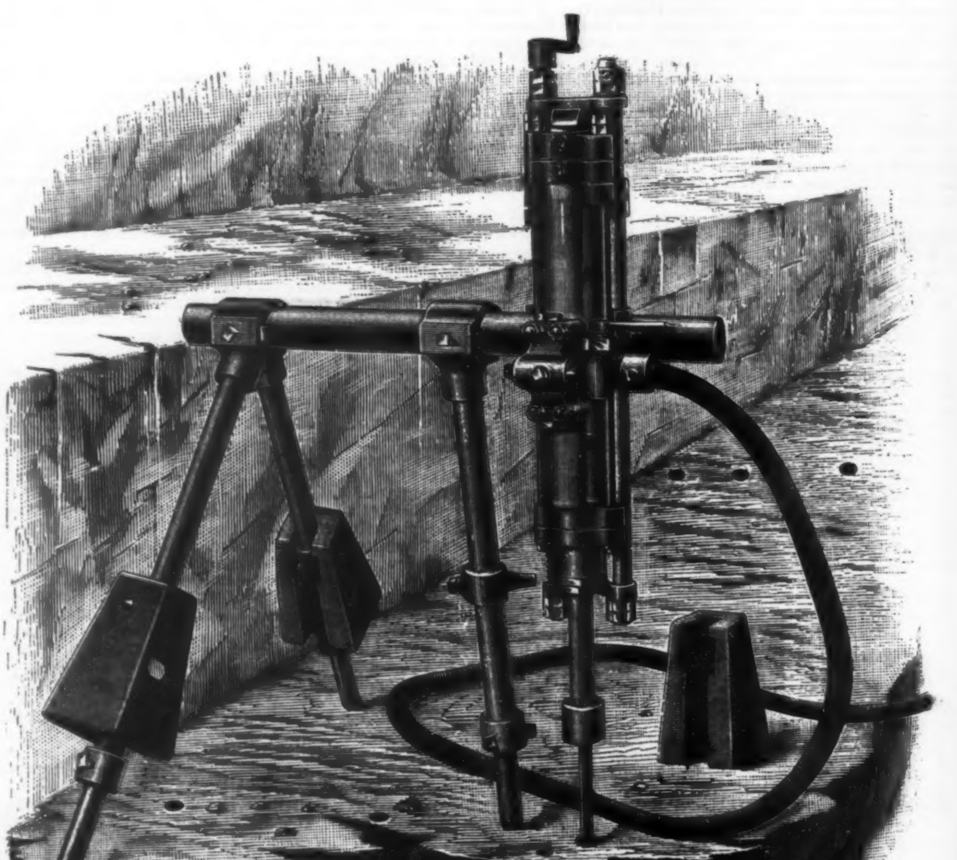


Fig. 1.

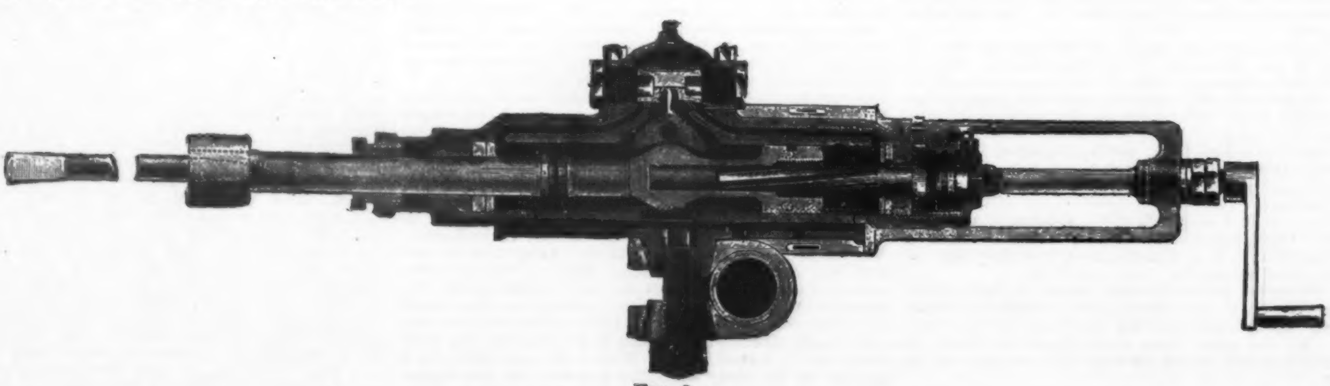


Fig. 2.

IMPROVED ROCK DRILL.

RAPID METHOD OF PAINTING A PASSENGER CAR.

By Robert McKeon.

The near approach of the World's Columbian Exposition has made it incumbent on the railway managements of the country to be up and doing, and all are busy putting their passenger equipment in first class order. The demands upon the railway paint shop, with cramped facilities, have forced us to reduce the time of painting a car, so that we may turn out a larger amount of work than has usually been done during the winter season, when the coaches are brought in for general repairs and painting, or cleaning up and revarnishing, as the case may be.

We have before us a new passenger car or one that has been rebuilt. It has been stripped on the outside and recovered with new paneling, or two-inch matched ceiling, which is the present style of finish. If a new head lining is necessary, the old one is taken out, and the inside finish is scraped so that it presents a new, clean surface. So we have a new car, so far as the painting is concerned, and in this article we will treat the outside, which we propose to finish in the least possible time, and for convenience we will call our method of painting the "A B C System," using no white lead whatever.

The priming coat of paint we put on in the wood shop, and there is always an abundance of time for it to dry before the car is ready for the paint shop. We give the first, or priming coat, with the surfacer A paint as soon as the work is ready, as it should not stand exposed after being finished by the woodworkers. This priming is the foundation for all subsequent coats. It penetrates the porous grain of the wood and gives us a sure protection against moisture. Our car is now ready for the paint shop, when we proceed with the painting, which we propose to complete and run out of the shop ready for service on the morning of the nineteenth day.

First Day. Give the body a light sandpapering with No. 1½ paper, to remove the dust that may have adhered to it while the priming was drying in the wood shop, and which gives the surface a slight tooth for the next coat, dust clean and apply a coat of the surfacer B paint, well brushed into the nail holes, of which there should be very few, as cars are now built, but all beading and defective places in the wood should be thoroughly filled, and just as great care should be exercised in the application of the foundation coats of paint as with the finishing coats.

Second Day. Putty up all nail holes, and give the letter board, the corner and door posts and window rail a coat of knifing filling or surfacer C paint. Put on quite heavy and scrape in smooth to fill the open grain of the wood. The matched ceiling does not require the scraping filler, but if the car has a panel finish it should be scraped in, as there is more uneven and open surface on panel work than on the narrow ceiling, and it requires the filling to make a good job.

Third Day. Sandpaper with No. 1½ paper lightly, and apply a coat of surfacer C paint in the afternoon, and let this stand over the fourth day for drying.

Fifth Day. In the morning give a second coat of the surfacer C paint; let dry until the morning of the seventh day, then give a thorough sandpapering with No. 1 paper. The car is now ready for the finishing or body color, which apply the same day in the afternoon.

Eighth Day. In the afternoon go over the color with moss or curled hair, so as to smooth down the surface and give the second coat of body color, and for the finishing color use a three inch bear hair fitch brush, which lays the color rapidly and smoothly, and being worked quickly it lays without showing ridges, which would show up were a bristle brush used.

The prepared or quick drying colors are in general use in all car shops, as all they require is reducing down to the proper working consistency with turpentine. There are but few shops that have the facilities for grinding and preparing their colors equal to the paint manufacturer, nor would it be economy for them to do so. The colors are made just right, and experience has fully proved that they are more reliable than the paints prepared and ground by the best of railroad paint shops. They are fully adapted to coach and car work where speed and durability combined is the main consideration.

The two coats of the body color we have given the car, whether it be Pullman color or Tuscan red, has sufficient depth or covering capacity for all practical purposes. So far as durability goes, we do not claim to have produced as fine a surface as may be had by rubbing with block pumice stone and water on the last coat of the surfacer C; but we have saved two days' time by not rubbing, and also $15 in labor up to this point, and our car is ready for the lettering and striping and any decoration that may be required to conform to the standard of the road.

Ninth Day. Rub the car down lightly with curled hair in the morning, to give a smoother surface on the flat color to gild on, and proceed with the lettering and striping; and if you have a sufficient number of good pencil hands to put on this part of the work, the car may be striped and lettered complete in one day; but the medium sized shop does not employ more than two or three of this class of hands, and we will require three days to complete it, and this brings us to the close of the eleventh day.

Twelfth Day. Give the first coat of wearing body varnish in the fore part of the day, and allow this to stand over the thirteenth and up to noon of the fourteenth day—forty-eight hours for drying.

Fourteenth Day. In the afternoon hair off the car to deaden the luster and flatten down the nibs on the varnish, and apply a second coat of the same grade of varnish. Do not be sparing of the varnish. Although it requires more time to give a heavy coat than a light one, it pays in the additional wear.

Use but one grade of varnish, and by following this rule we remove all danger of the varnish cracking after the car has gone into service. Let the second coat of varnish dry over the fifteenth and up to noon of the third sixteenth day, and we are ready to apply the third and last coat, although a very fair job has been done with the two coats, which on the cheaper class of cars may be sufficient; but we are doing a first class job of body painting, and will give our best cars three coats of wearing body varnish.

Sixteenth Day. In the afternoon hair off the varnish lightly to deaden the gloss. This, also, is of assistance in varnishing, as the varnish spreads more evenly over the deadened surface. Now give the car the third and last coat and let this dry over the seventeenth and eighteenth days, and on the morning of the nineteenth day the car is ready to leave the shop and to go into service.

While the outside of the car has been progressing we have been pushing the inside work, the sash and blinds have been finished in the varnish room and have been turned over to the men who do the fitting up of the car at noon on the seventeenth day. This gives them one and a half days to put in the sash and blinds and put on the trimmings, and this can be done so as to allow time for giving the floor the last coat of paint late in the afternoon of the eighteenth day, as this is the last work of the painter to be done after the fitting up is complete.

The details of painting the roof, trucks and steps, blacking off, etc., it is unnecessary to enter into. This has all been done while the body painting has been going forward, as this must take the greatest length of time, owing to the number of coats required. As the constant exposure which the car is subjected to demands that a good and durable job of painting should be done, nine coats of paint and varnish have been applied to the body of the car. We have not aimed to produce a fine surface, no rubbing either on the surfacing coats of paint or on the varnish has been done; but the passenger coach painted in this way will give as satisfactory results as those that are turned out with a finer surface that requires one third longer time for finishing as well as a third additional expense for labor.—*National Car Builder.*

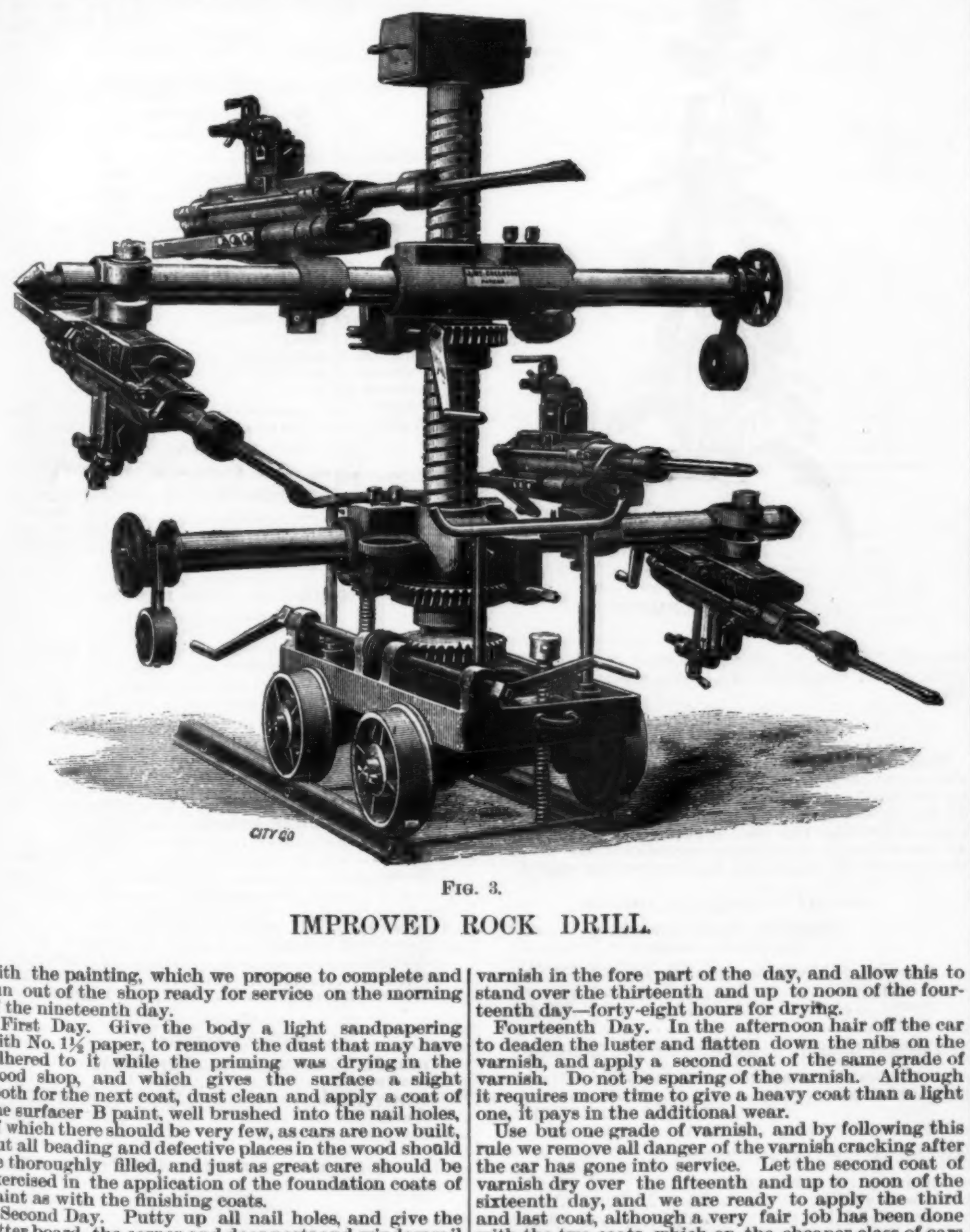
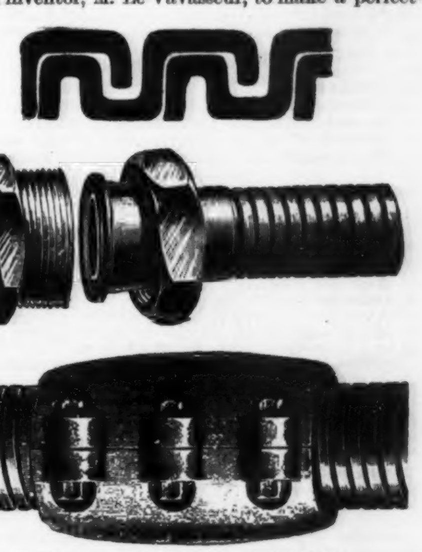


Fig. 3.

IMPROVED ROCK DRILL.

FLEXIBLE METALLIC TUBING.

For many years inventors have attempted to find a metallic substitute for the ordinary India rubber tubing. The first flexible metallic tube was made of a number of annular segments, fitting into each other in such a way that a small amount of play was allowed for the two surfaces to slide over each other. Then many methods were tried by building up a tube by spirally winding a corrugated strip of metal, and allowing a similar amount of play between each convolution. Both of these kinds of tube presented the disadvantage inherent in all joints consisting of sliding surfaces; that is, the difficulty of making the joint airtight and watertight. In order to make the joint perfectly airtight, inventors then inserted small strips of India rubber between the convolutions. This had, of course, the desired effect, but the India rubber strip was found to be exceedingly perishable, and the tube was in other ways just as open to objection as the plain India rubber tube. Inventors then had recourse to other devices, such as the combination of several layers of metal wires, the strands of each fitting into the recesses of the others. Some of these designs have met with more or less success, though none can be said to be quite satisfactory. It has been left to a French inventor, M. Le Vavasseur, to make a perfectly satisfactory flexible metallic tube. He experimented for years with almost every conceivable form of tube, but eventually succeeded in getting a quite simple design to give eminently satisfactory results. The tube is built from a single strip of metal, previously corrugated in a special manner, and spirally wound on itself. There is no packing whatever between the convolutions, and yet the tube will withstand ordinary steam pressure for an indefinite period. A cross section of a wall of the tube is shown in Fig. 1. It will be seen that the strip has two channels formed in it, one larger than the other, and that the larger channel of one convolution overlaps the smaller one of the next convolution. The smaller channel is also much narrower than the larger one, so that considerable play is allowed between each convolution. Engineers and mechanics have been at a loss to account for the strength of the tube and its perfect airtightness, and several theories have been advanced, for it is remarkable that this design should be so successful with M. Le Vavasseur after it had failed to give satisfactory results before. Whatever may be the cause, the result is without doubt, for the tubing has been in use in all sorts of installations for some time, and has made good all its inventor's claims and promises. Special machinery of high order has been designed for the manufacture of the tubing. It is made in one continuous operation from a ribbon of tough steel. The weight of a 5-16 in. tube is 2½ oz. per ft., a ⅝ in. tube weighs 8½ oz. per ft., and a 1 in. tube weighs 11 oz. per foot. A ¾ in. tube is made from a strip of metal 0·6 mm. thick and 14 mm. wide.



FLEXIBLE METALLIC TUBING.

The industrial application of such a tubing depends first on the degree of its flexibility, and, secondly, on its capability to resist the attacks of the fluid conveyed through it. The metal tubing is naturally much less flexible than any India rubber, but its strength and durability are immensely superior. It is capable of withstanding far greater internal pressure, and it is able to transmit suction, which the rubber tube cannot do. Then, again, it is not injured so much by bodies passing over it and falling on it; it can also bear weights hanging on it. It has many advantages over a solid metal pipe. For instance, it does not burst under frost, for its joints allow of sufficient contraction and expansion.

This form of flexible metallic tubing has been used with great success for conveying compressed air to rock

drills; for carrying steam under 150 lb. pressure; for supplying Pintsch gas to railroad cars, at 200 lb. per sq. in. pressure; and in beer engines, speaking tubes, organ blowing machines, carpet cleaning machines, etc. It has also been applied successfully as a sheathing for electric wires and small cables.

With a tube of this sort, it is necessary that there should be some means of making a good and secure joint or coupling. This has been done by a simple screw connection—Fig. 2—the end of the tube being inserted into a conical cup, into which it is fastened by white lead or solder. A simple push-on connection may be used for gas. For a strong joint for low pressure a plain collar made in halves and capable of being bolted round the junction with a packing of India rubber is all that is required, as in Fig. 3. These illustrations have been taken from a paper read before the last meeting of the British Association by Mr. Gilbert Redgrave.

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

PART II.—CHAPTER III. (*Continued.*)

Cumin.
Eau-de-vie de Dantzig.

Cinnamon (Ceylon)	25 grm.
Cloves	1·5 grm.
Green anise	12·5 grm.
Celery seed	12·5 grm.
Caraway seed	12·5 grm.
Cumin seed	3 grm.
Alcohol (85°)	5 l.
Sugar (white)	2 k. 500 grm.

Usual method, without rectification.
Product, 10 l.

Kummel of Dantzic.

Cumin seeds	450 grm.
Coriander	30 grm.
Orange peel	15 grm.
Alcohol (80)	5 l. 65 c. c.
White sugar	2 k. 500 grm.

Kummel of Breslau.

Cumin seeds	450 grm.
Chinese cinnamon	10 grm.
Fennel	15 grm.
Alcohol (80°)	5 l. 65 c. c.
White sugar	2 k. 250 grm.

Genepi or Genipi.
Crême de Génépi des Alpes.

Genepi flowers	200 grm.
Peppermint in flower	100 grm.
Costmary balsamite	100 grm.
Angelica root	50 grm.
Galanga	12·5 grm.
Alcohol	4 l. 25 c. c.
White sugar	3 k. 75 grm.

General method, same as for other liquors; color, apple green.

Juniper.
Liqueur de Genièvre.

Crushed juniper berries	600 grm.
Coriander	20 grm.
Crushed Florentine orris	40 grm.
Alcohol (80°)	5 l. 650 c. c.
Sugar	1 k. 800 grm.

General method, macerate for 5 days, distill gently, without rectification.
Product 10 l., color olive green.

Balm.
Eau de Mélisse des Carmes.

Balm, fresh and in flower (*Melissa officinalis*)	3 k. 500 grm.
Tops of hyssop in flower	125 grm.
Tops of marjoram	125 grm.
Tops of romarin	125 grm.
Tops of sage	125 grm.
Tops of thyme	125 grm.
Angelica root	125 grm.
Coriander	125 grm.
Ceylon cinnamon	60 grm.
Mace	15 grm.
Nutmegs	45 grm.
Peels of 10 lemons.	
Alcohol (85°)	11 l.

Macerate for three days, distill over water bath, and add 10 l. of water. Draw off 10 l. of good liquor.

Peppermint.
Menthe Poivreé.

The peppermint plant (Fig. 50) has a penetrating odor somewhat resembling camphor; strong taste of mint, reddish stem, height 18 or 20 in., leaves green, flowers purplish.

Crême de Menthe (Fr. and Eng.)

Peppermint	600 grm.
Balm	40 grm.
Sage	10 grm.
Cinnamon of Ceylon	20 grm.
Florentine orris root	10 grm.
Ginger	15 grm.
Alcohol (80°)	5 l. 30 c. c.
White sugar	2 k. 250 grm.

Same method of operation as for other liquors.
Product, 10 l.

Maraschino.
Marasquin.

Ripe wild cherries	90 k.
Raspberries	12 k.
Cherry leaves	5 k.

Crush the fruit and ferment; add, before distillation, 750 grm. of peach nuts and 500 grm. of orris; distill gently, so as to draw off all the alcohol; rectify to 85°, and add cold a sirup composed of 1 k. 850 grm. of sugar per l. of perfumed alcohol; raise the volume to 10 l. by adding 3 l. 500 c. c. of alcohol.

Oranges.
Curaçoa.

Rasped skins of	18 or 20 oranges
Cinnamon (Ceylon)	4 grm.
Mace	2 grm.
Alcohol (85°)	5 l.
White sugar	1 k. 750 grm.

Macerate for 14 days, distill over a water bath, without rectification, as has already been described.
Product, 10 l.; color yellow, with caramel.

Bitter Curaçoa.

Green anise	40 grm.
Juniper berries	40 grm.
Orange peel, sour and dry	40 grm.
Sage	40 grm.
Large absinthe	40 grm.
Sweet flag	40 grm.
Cloves	20 grm.
Peppermint	20 grm.
Lavender flowers	20 grm.
Angelica	20 grm.

All the plants, which must be in a dry state, divided and contused, are macerated for two days with 5 l. 500 c. c. of alcohol, 80°; distill after having added 3 l. of water and drawing off 5 l., then add a cold sirup made from 1 k. 750 grm. of sugar dissolved in 3 l. of water; bring up the volume to 10 l., color with caramel and filter.

FIG. 50.—PEPPERMINT.

CHAPTER IV.

Liquors Made by Infusion.

This method of preparation is applied to some substances where it is impossible to extract the perfume by distillation with either alcohol or water. Almost all the liquors made by infusion are known under the name of ratafias; this term is applied very loosely. In all the following receipts the ingredients are given on the basis of 10 l. of alcohol, unless otherwise stated.

SECTION I.—ORDINARY LIQUORS.

Ratafia of Black Currant.
Ratafia de Cassis.

Infusion of black currants (first)	2 l. 500 c. c.
Alcohol (85°)	1 l. 200 c. c.
Sugar	1 k. 250 grm.
Water	5 l. 400 c. c.

If a second infusion is desired, take the following:

Infusion of currants (second)	3 l. 200 c. c.
Alcohol (85°)	600 c. c.
Sugar	1 k. 250 grm.
Water	6 l. 400 c. c.

And for the third infusion take

Infusion of cassis (third)	3 l. 200 c. c.
Alcohol (85°)	700 c. c.
Sugar	1 k. 250 grm.
Water	3 l. 900 c. c.

In case there is not sufficient perfume, add two or three c. c. of essence or an infusion of the leaves of cassis, diluted with an equal quantity of alcohol.

Quince.
Ratafia de Coings.

Expressed juice of ripe quinces	600 c. c.
Essence of cloves	50 c. c.
Alcohol	2 l. 500 c. c.
Sugar	1 k. 250 grm.
Water	6 l.

Color clear yellow, with caramel.

Raspberry.

Infusion of raspberries	1 l. 500 c. c.
Infusion of cassis	500 c. c.
Alcohol (85°)	1 k. 200 grm.
Sugar	1 k. 250 grm.
Water	5 l. 900 c. c.

Walnut.
Brou de Noix.

Infusion of old walnut shells	2 l. 100 c. c.
Essence of nutmeg	25 c. c.
Alcohol	1 l. 300 c. c.
Sugar	1 k. 500 grm.
Water	5 l. 700 c. c.

Color with caramel.

Vanilla.
Huile de Vanille.

Infusion of vanilla	100 c. c.
Tincture of *storax calimite*	25 c. c.
Alcohol	2 l. 400 c. c.
Sugar	1 k. 250 grm.
Water	6 l. 600 c. c.

Color with orchol.

SECTION II.—DOUBLE LIQUORS.

Cassis.
Ratafia de Cassis.

Infusion of cassis (first)	5 l.
Alcohol (85°)	2 l. 400 c. c.
Sugar	2 k. 500 grm.
Water	1 l.

Walnuts.

Infusion of walnut shells	4 l. 200 c. c.
Essence of nutmegs	0 l. 50 c. c.
Alcohol (85°)	2 l. 500 c. c.
Sugar	2 k. 500 c. c.
Water	1 l. 800 c. c.

Color with caramel.

Vanilla.
Huile de Vanille.

Infusion of vanilla	200 c. c.
Alcohol (85°)	4 l. 800 c. c.
Sugar	2 k. 500 grm.
Water	3 l. 300 c. c.

Color with orchol.

SECTION III.—LIQUORS (*Demi-Fines*).

Ratafia of Cherries.
Ratafia de Cerises.

Infusion of cherries	3 l.
Infusion of wild cherries	500 c. c.
Essence of apricot kernels	500 c. c.
Alcohol	400 c. c.
Sugar	2 k. 500 c. c.
Water	3 l. 900 c. c.

Ratafia of Four Fruits.
Ratafia des Quatre Fruits.

Infusion of cassis (first)	1 l.
Infusion of cherries	1 l.
Infusion of raspberries	800 c. c.
Infusion of wild cherry	800 c. c.
Alcohol (85°)	800 c. c.
Sugar	2 k. 500 grm.
Water	3 l. 900 c. c.

Vanilla.
Huile de Vanille.

Infusion of vanilla	0 l. 400 c. c.
Alcohol (85°)	2 l. 200 c. c.
Sugar	2 k. 500 grm.
Water	5 l. 500 c. c.

Color with cochineal.

SECTION IV.—FINE LIQUORS.

Cassis.

Infusion black currants	3 l. 600 c. c.
Infusion of raspberries	800 c. c.
Alcohol (85°)	1 l.
Sugar	3 k. 750 grm.
Water	2 l. 100 c. c.

Cherry.
Ratafia de Cerises.

Infusion of cherries	3 l. 500 c. c.
Infusion of wild cherries	800 c. c.
Essence of apricot kernels	600 c. c.
Alcohol (85°)	400 c. c.
Sugar	3 k. 750 grm.
Water	2 l. 100 c. c.

Walnut.

Infusion walnut shells	3 l.
Essence of nutmegs	35 c. c.
Alcohol	1 l. 500 c. c.
Sugar	3 k. 750 grm.
Water	2 l. 900 c. c.

Vanilla.
Huile de Vanille.

Infusion of vanilla	800 c. c.
Alcohol (85°)	2 l. 400 c. c.
White sugar	4 k. 375 c. c.
Water	3 l. 900 c. c.

Color with cochineal.

SECTION V.—SUPERFINE LIQUORS.

Pineapple.
Creme d'Ananas.

Pineapples, fresh gathered	800 grm.
Alcohol (85°)	4 l.

Crush the pineapple and infuse in alcohol for eight days, pass through a silk sieve, throw the crushed sugar into 2 l. 200 c. c. of water, add 50 c. c. infusion of vanilla. Color clear yellow with caramel.

Angelica.
Hygienic Dessert Liquor Formula of Raspail.
Liqueur Hygienique de dessert (*Raspail*).

Alcohol (56°)	100 c. c.
Angelica root	3 grm.
Calamus (sweet flag)	0·2 grm.
Myrrh	0·2 grm.
Cinnamon	0·2 grm.
Aloes	0·2 grm.
Cloves	0·1 grm.
Vanilla	0·1 grm.
Camphor	0·05 grm.
Nutmegs	0·025
Saffron	0·005

* Continued from page 14250, SUPPLEMENT No. 892.

Allow the materials to digest for several days in a well-corked bottle placed in the sun. Strain through a fine cloth and bottle; keep well corked.

Ratafia of Currants of Dijon.
Ratafia de Cassis de Dijon.

Infusion of currants (first)	2 l. 500 c. c.
Infusion of cherries	500 c. c.
Infusion of wild cherries	500 c. c.
Infusion of raspberries	500 c. c.
Bordeaux wine	1 l.
White sugar	5 k.
Water	1 l. 600 c. c.

Ratafia of Cherries of Grenoble.
Ratafia de Cerises de Grenoble.

Infusion of cherries	2 l. 500 c. c.
Infusion of wild cherries	1 l. 500 c. c.
Essence of apricot kernels	600 c. c.
Essence of raspberries	400 c. c.
White sugar	5 k.
Water	1 l. 600 c. c.

Ratafia of Raspberries.

Infusion of raspberries	3 l.
Infusion of wild cherries	1 l.
Alcohol (85°)	1 l.
White sugar	5 k.
Water	1 l. 600 c. c.

Ratafia of Wild Cherries of Grenoble.

Put in a bright copper vessel 10 k. of wild cherries, ripe and stemmed, heat rapidly and stir with a wooden spatula until the liquid is thick; then throw the mass in a large vessel and, after cooling, add 5 l. 500 c. c. of white brandy at 59°. Let the mixture infuse six days or less, stirring from time to time; draw off and let the liquor clarify itself.

Walnuts.
Crème de brou de noix.

Infusion of old walnut shells	4 l.
Essence of nutmegs	50 c. c.
Alcohol (85°)	1 l.
White sugar	5 k.
Water	1 l. 600 c. c.

Pears
Crème de Poires de Rousselets.

This liquor is prepared in the same way as *Creme d'Ananas* (Pineapple).

Russet pears, ripe	1 l.
Essence of raspberries	1 l.
Infusion of vanilla	0 l. 200 c. c.
Alcohol (85°)	2 l. 800 c. c.

Vanilla.
Crème de Vanille.

Infusion of vanilla	1 l.
Alcohol (85°)	2 l. 600 c. c.
White sugar	5 k. 500 grm.
Water	2 l. 600 c. c.

Color with cochineal.

CHAPTER V.
Liquors prepared from Essences.

Liquors are readily prepared from essences; in general the method of manufacture is to dissolve a certain quantity of the essential oil in alcohol, and reduce the solution to the desired degree by the addition of water and sugar if necessary. The quality of liquor prepared by this process depends upon the quantity of water and essential oil and the quality of the alcohol employed. The proportions generally used are as follows for 10 l. of liquor:

	Alcohol.	Sugar.	Water.
Ordinary liquors	2 l. 500 c. c.	1 k. 250 grm.	6 l. 600 c. c.
Demi-fines "	2 l. 800 c. c.	2 k. 500 grm.	5 l. 500 c. c.
Fine "	3 l. 200 c. c.	4 k. 375 grm.	3 l. 800 c. c.
Superfine	4 l.	5 k. 600 grm.	2 l. 600 c. c.

The method generally adopted presents no difficulties. A flask or other glass vessel is carefully cleansed, dried and placed on one of the pans of a balance. The essences are added to part of the alcohol so as to fill the vessel to two-thirds of its capacity. Cork and shake until the essences are completely dissolved. The solution is mixed with the remainder of the alcohol and the whole is briskly shaken. The usual processes of treating with sirup, coloration, clarification, filtration after repose, etc., are conducted as already described.

SECTION I.—ORDINARY LIQUORS.
Liqueurs Ordinaires.

Absinthe.
Absinthe Ordinaire.

Essence of absinthe	0·6 grm.
Essence of English mint	0·6 grm.
Essence of green anise	3 grm.
Essence of lemon	3 grm.
Essence of fennel	0·8 grm.
Alcohol (85°)	2 l. 500 c. c.
Sugar	1 k. 250 grm.
Water	6 l. 600 c. c.

Color green.

Superfine Absinthe.
Absinthe Surfine.

Essence of absinthe	1 grm.
Essence of mint	0·75 grm.
Essence of fennel	0·75 grm.
Essence of green anise	3 grm.
Essence of lemon	3 grm.
Alcohol (85°)	4 l.
Sugar	5 k. 600 grm.
Water	2 l. 600 c. c.

Cream of Absinthe.
Crème d'Absinthe.

Essence of absinthe	15 grm.
Alcohol (90°)	5 l.
Sugar	4 k. 500 grm.

Make a sirup with the sugar and one-half its weight of water and cool. Dissolve the essence and mix. Increase the mixture to 10 l., color green and filter.

Angelica.
Eau d'Angelique.

Essence of angelica	0·6 grm.
Alcohol (85°)	2 l. 500 c. c.
Water	6 l. 600 c. c.
Sugar	1 k. 250 grm.

Anisette (Ordinary).

Essence of anise	3 grm.
Essence of star anise	3 grm.
Essence of sweet fennel	0·5 grm.
Essence of coriander	0·05 grm.
Alcohol (85°)	2 l. 500 c. c.
Water	60 l. 600 c. c.
Sugar	1 l. 250 grm.

Anisette (*demi-fine.*)

Essence of anise	3·2 grm.
Essence of star anise	3·2 grm.
Essence of sweet fennel	60 grm.
Essence of coriander	0·05 grm.
Essence of French neroli	0·1 grm.
Alcohol (85°)	2 l. 800 c. c.
Water	5 l. 500 c. c.
Sugar	2 k. 500 grm.

Lemon.
Parfait Amour.

Essence of lemon (distilled)	4·5 grm.
Essence of cedrat (distilled)	1·5 grm.
Essence of coriander	0·1 grm.
Alcohol (85°)	2 l. 600 c. c.
Water	6 l. 600 c. c.
Sugar	1 k. 250 grm.

Color with orchol.

Mint.
Menthe Anglaise.

Essence of English mint	2 grm.
Alcohol (85°)	2 l. 500 c. c.
Water	6 l. 600 c. c.
Sugar	250 grm.

Crème de Menthe.

Essence of English mint	3·5 grm.
Alcohol (85°)	2 l. 800 c. c.
Water	5 l. 500 c. c.
Sugar	2 k. 500 grm.

Noyau.
Crème de Noyau demi-fine.

Essence of noyau	5 grm.
Alcohol	2 l. 800 c. c.
Water	5 l. 500 c. c.
Sugar	2 k. 500 grm.

Orange.
Curaçao Ordinaire.

Essence of curacao	4 grm.
Essence of Portugal distilled	1·5 grm.
Essence of cloves	0·2 grm.
Alcohol (85°)	2 l. 500 c. c.
Water	6 l. 600 c. c.
Sugar	1 k. 250 grm.

Color with caramel.

Curaçao (*demi-fine*).

Essence of curacao, distilled	5 grm.
Essence of Portugal	2 grm.
Essence of cloves	0·4 grm.
Alcohol (85°)	2 l. 800 c. c.
Water	5 l. 500 c. c.
Sugar	2 k. 500 c. c.

Color with caramel.

Orange Flowers.
Creme de fleurs d'Oranger.

Essence of French neroli	1·2 grm.
Alcohol (85°)	2 l. 800 c. c.
Water	5 l. 500 c. c.
Sugar	2 k. 500 grm.

Rose.
Huile de Rose.

Essence of roses	0·8 grm.
Alcohol (85°)	2 l. 800 c. c.
Water	5 l. 500 c. c.
Sugar	2 k. 500 grm.

Vespétro.

Essence of anise	3 grm.
Essence of cassis	2 grm.
Essence of sweet fennel	0·6 grm.
Essence of coriander	0·8 grm.
Essence of lemon, distilled	1 grm.
Alcohol (85°)	2 l. 800 c. c.
Water	2 l. 600 c. c.
Sugar	2 k. 500 grm.

SECTION II.—FINE LIQUORS.
Liqueurs Fines.

Anisette.

Essence of star anise	5 grm.
Essence of anise	0·2 grm.
Essence of sweet fennel	0·6 grm.
Essence of coriander	0·1 grm.
Essence of sassafras	0·4 grm.
Essence of orris	4 grm.
Essence of ambrette (amber seed)	0·6 grm.
Alcohol (85°)	3 l. 200 c. c.
Water	3 l. 900 c. c.
Sugar	4 k. 375 grm.

Cream of Celery.
Crème de Celeri.

Essence of celery	2 grm.
Alcohol (85°)	3 l. 100 c. c.
Water	3 l. 900 c. c.
Sugar	4 k. 375 grm.

Curaçao.

Essence of curacao, distilled	7 grm.
Essence of Portugal	2·5 grm.
Essence of cloves	0·5 grm.

Bitter infusion of curacao, a sufficient quantity.

Alcohol (85°), sugar and water, same quantities as for anisette.

Eau-de-vie de Dantzig.

Essence of cinnamon (Ceylon)	0·4 grm.
Essence of cinnamon Cluria	1·2 grm.
Essence of coriander	0·2 grm.
Essence of lemon, distilled	2·5 grm.
Essence of Portugal, distilled	0·8 grm.

Alcohol (85°), water and sugar as above.

Elixir de Gorus.

Essence of Chinese cinnamon	1·2 grm.
Essence of cloves	0·6 grm.
Essence of musk	0·2 grm.
Socotrine aloes	4 grm.
Saffron	0·4 grm.
Myrrh	2·5 grm.

After dissolving the essences, make an infusion of the aloes, myrrh, and saffron for three days in alcohol. Same quantity of 85° alcohol, water and sugar as before. Color with caramel.

Crème de Menthe.

Essence of English mint	5 grm.

Alcohol (85°), water and sugar, same quantities as above.

Eau de sept graines.

Essence of angelica	0·3 grm.
Essence of anise	1·5 grm.
Essence of celery	0·5 grm.
Essence of coriander	0·1 grm.
Essence of sweet fennel	0·5 grm.
Essence of Portugal, distilled	0·5 grm.
Essence of lemon, distilled	5 grm.

Alcohol (85°), water and sugar, same proportions as already indicated. Color with caramel.

(*To be continued.*)

COLOR VISION.

THE report presented to the Royal Society by the Committee on Color Vision is, says the *Lancet*, both interesting and important. The committee held no less than thirty meetings and examined more than 500 individuals as to their color vision. They also took the evidence of various officials connected with marine and railway work, as well as of several surgeons and experts in testing for color vision. The results of such an exhaustive inquiry are of the highest importance, and seeing that the conclusions at which the committee arrived have as a natural corollary the framing of certain recommendations with reference to the examination of individuals in whom, for efficient work in their various posts, good color vision is a necessity, it is to be expected that their labors will have important practical results.

The report deals in the first place with the nature of color vision, and a short and succinct account is given of the Young-Helmholtz theory of color vision and of that of Hering. The defects in the ordinary forms of color blindness are described and also those defects which arise in consequence of disease or injury. The dangers from mistaking signals likely to arise from these defects are pointed out; and while it is stated that no direct evidence had come before the committee showing that accidents on land or water have been conclusively traced to such defects, yet the absence of such conclusive evidence does not disprove the high probability that such accidents have really occurred in consequence of such defects. It is evident that every color blind person employed in certain capacities afloat and on shore must be a source of public danger, and one significant fact is stated showing the probability that some years ago at least a considerable number of sailors were employed who were defective in their color vision.

The fact referred to is the existence of color blindness in 4 per cent. of the orphan children of sailors on training ships. As it is well known that color blindness is to a large extent hereditary, it may be assumed as more than probable that a considerable number of the fathers of these orphans suffered from this defect; and the unsatisfactory nature of the tests officially adopted by the Board of Trade for color testing of the marine service does not lessen this probability. It is, however, satisfactory to find that the different tests employed in the Royal Navy are regarded by the committee as most efficient.

The chief recommendations as stated in the letter of Lord Rayleigh, chairman of the committee, are that the Board of Trade or some central authority should schedule certain employments in the mercantile marine and on railways, the filling of which by persons whose vision is defective, either for color or form, or who are ignorant of the names of colors, would involve danger to life or property, and that the proper testing of all candidates for such employment should be compulsory. This testing should be intrusted to examiners certificated by the central authority, the test to be used for color vision being that of Holmgren (the sets of wools to be approved by the central authority), and the tests for form those of Snellen. A certificate of the candidate's color vision and form vision should be given by the examiner, and lists sent annually to the central authority showing the results and stating the nature of the employments for which examinations were held; while rejected candidates may have the right of appeal to an expert approved by the central authority, whose decision should be final. If, however, a candidate whose color vision is normal is rejected for naming colors wrongly, it is recommended that he should be allowed to be re-examined after a proper interval of time. Re-examination of persons filling the scheduled employments is suggested every third year or oftener, as well as periodical inspection of the tests and mode of examination at the different testing stations. The committee also recommended that the colored lights for ships and for lamp signals on the railway should, as far as possible, be uniform, the colors adopted being those of the green and red sealed pattern glasses of the Royal Navy; and that in the case of judicial inquiries regarding collisions or accidents witnesses giving evidence as to the nature or position of colored signals or lights should themselves be tested for color and form vision.

The immense importance of the subject is evident, and the practical and thorough nature of the suggested measures must recommend them to every one.

LUTHER'S CHURCH IN WITTENBERG.

THANKS to its great past, the venerable old "Luther Town," on the Elbe, is accustomed to see within its walls, from time to time, besides the daily visitors who, like birds of passage, rest in their flight on Wittenberg and then hurry off again, processions that pass with reverent steps into the consecrated rooms of the old Schlosskirche (castle church), the cradle of the reformation and the sepulcher of the reformers.

Our gaze is now turned again to Wittenberg, where an evangelical emperor, surrounded by evangelical princes, lent pomp to the "Luther Day" and joined with the congregation in dedicating the recently restored Schlosskirche. This is the third time that these halls have been dedicated, and naturally memory goes back and compares the present with the past. How life has changed inside and outside of this church!

Let us look back to the first consecration of the Schlosskirche on October 31, 1503. The Bishop of Gurk, Cardinal Legate Raymund Payrand, came with great pomp at the head of the clergy, sent by the Pope in response to the invitation of the Elector Friedrich the Wise. After uttering a Latin prayer, he passed around the building three times, sprinkling the walls with holy water. Then he went inside and blessed the different parts of the church. The other members of the clergy then passed in with the gold-ornamented relic chests, and proclaimed the bishop patron of the church "To the honor of God and of the glorious Virgin Mary, and in memory of the dear saints." The consecration was ended. Then the service began, and absolution can be obtained at the nineteen altars of the church. By the pious zeal of the elector, this house of God was provided with a treasure room containing 5,005 relics, which, together, represented 500,000 days of absolution.

It is the anniversary of this first dedication, and the date is written "the year of our Lord 1517." In celebration of the day the relics are exhibited and the crowd presses in. In the evening there is a dispute at the door of the church; an Augustinian monk, Brother Martinus, questions the "power and worth of absolution." A theme indeed! a subject as timely and attractive then as a discussion of the social question would be now. But he who started this discussion is no learned man of the ordinary kind; Martin Luther is

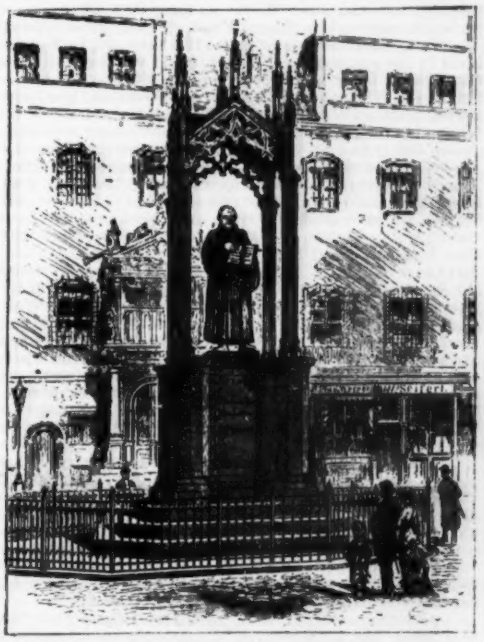
LUTHER'S CHURCH IN WITTENBERG, AS RESTORED.

the religious genius of his time, and the subject is the reformation of the church.

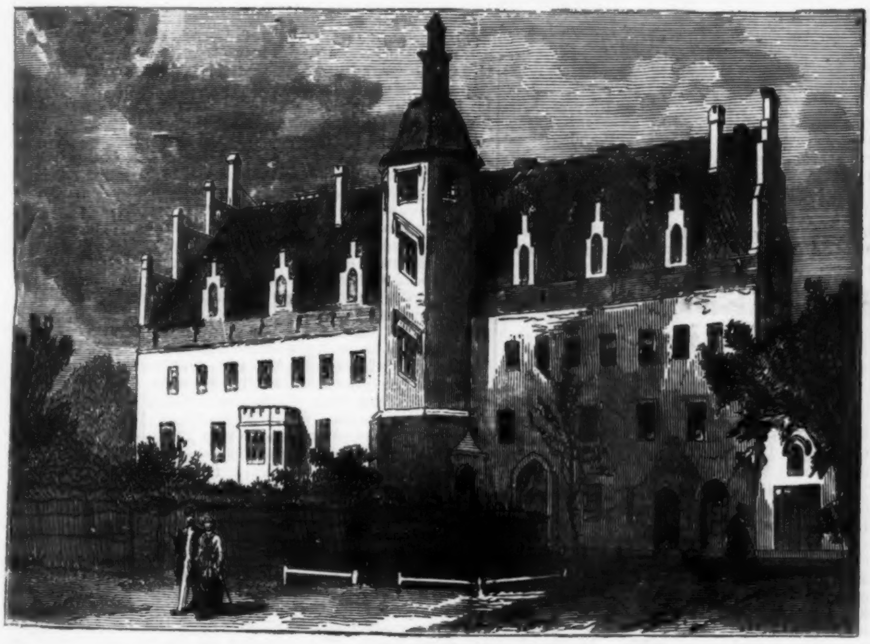
Then 253 years pass over the Schlosskirche. It is August 6, 1770, when the church in Wittenberg is dedicated again, the reason for this second ceremony being the renovation of the church after its having been reduced to ashes by the Seven Years' War. The Latin inscription over the door shows that henceforth it was to be consecrated "to God in the Highest only." Although the same inscription stated that the church had risen more beautiful after the fire, this could scarcely compensate for the loss of that which could not be replaced; the precious pictures of Cranach and Durer, and more especially the celebrated Thesis Door, and many other things that were lost in the flames. The new church was destitute of monuments, also. But the spirit of the times, the time of simple rationalism, left its stamp on the building. Although the new church tower, in baroque style, serves the chronicler as an ornament and decoration of the landscape, now it looks rather odd to us; the vases over the Thesis Door, instead of statues in niches, were tiresome; the arrangement of the pulpit above the altar was unsuitable and monotonous to the smooth, undecorated surfaces of the woodwork of the great double gallery. The handwork was well done, but there was scarcely anything of the old artistic work.

It is 1892. The newly finished church is to be dedicated for the third time. Rationalism and the baroque style have passed away, but what meets the eye and ear of the devout congregation on Oct. 31 is worthy of the past of this edifice. Mentally, we make a circuit of the new halls, for they can be called new, as very little more than the walls of the old building is left. In the restoration, however, the idea of Prof. Adler, by whom the work was done, was to save as much of the old part as possible, and while planning conscientious additions in the original style to avoid making a servile copy of anything that was demolished or destroyed by fire, thus producing an appropriate, artistically beautiful structure in which the old style was reverently preserved. The restoration is true to history, but as the style is in perfect harmony with modern art work a very fine result has been obtained. Let us take

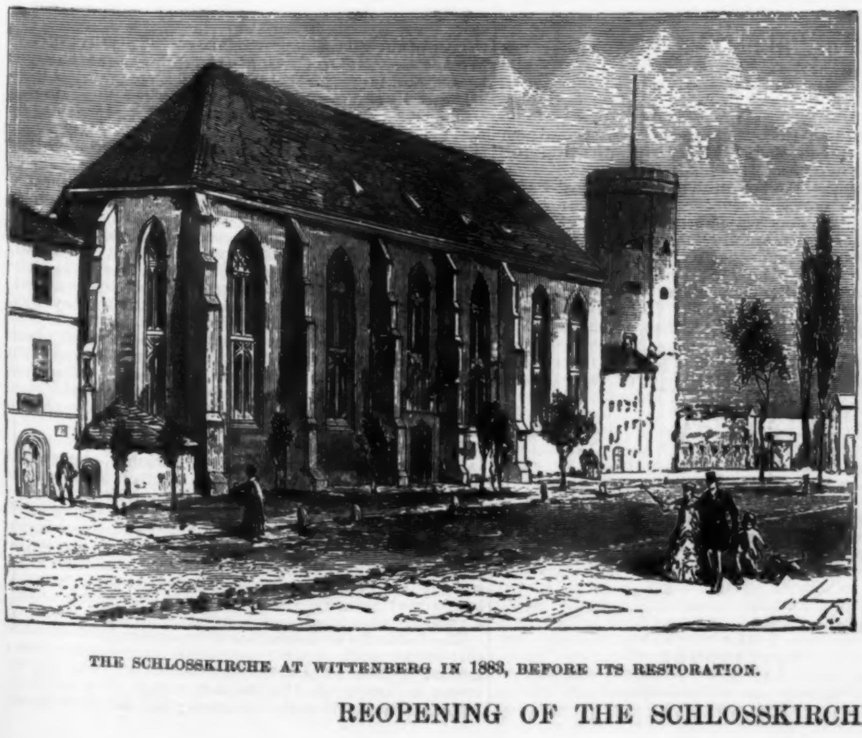
LUTHER'S STUDY AT THE UNIVERSITY OF WITTENBERG.



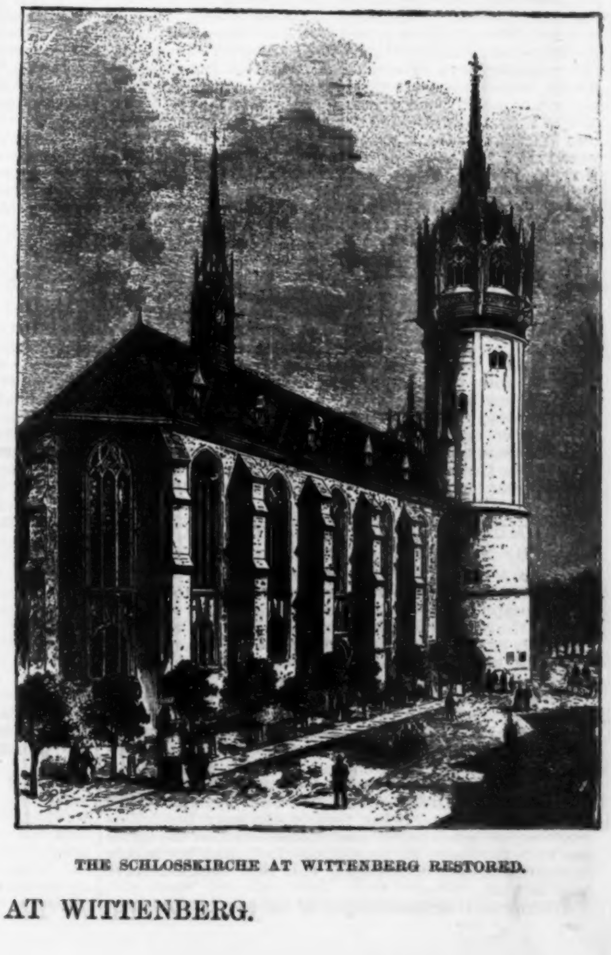
LUTHER MONUMENT AT WITTENBERG.



THE UNIVERSITY OF WITTENBERG (OLD AUGUSTINIAN MONASTERY).



THE SCHLOSSKIRCHE AT WITTENBERG IN 1883, BEFORE ITS RESTORATION.



THE SCHLOSSKIRCHE AT WITTENBERG RESTORED.

REOPENING OF THE SCHLOSSKIRCHE AT WITTENBERG.

our stand in the organ loft; there we overlook the whole and get the effect that caused the Emperor to exclaim when he stood leaning against the rail, "Beautiful, beautiful!" Indeed, the forms and masses of this late Gothic style are beautiful, and it is unfortunate that they are very seldom used in this way in our church edifices. Slender octagonal pillars divide the nave into three aisles, and the end of the choir is semi-hexagonal. The roof, which is vaulted and deeply ribbed, is ornamented with fresco painting. This is the characteristic feature of the old style. Colors are much used. The coats of arms that are arranged in relief on the railing of the gallery are colored and the capitals of the columns that support the statues of the heroes of the reformation are also colored. The idea of making this a memorial hall for the leading spirits of the reformation is carried still further in the twenty-two bronze medallions in the corners above the arches under the gallery and in the eight windows of the nave. The medallions represent princes, artists, and humanists who lived before and at the time of the reformation: in the windows are 198 coats of arms of the Protestant cities, arranged according to the old provinces. Our view is limited by the three colored glass windows of the choir, the subjects of which were taken from the so-called "Little Passion" of Durer. The dazzling white altar stands out in relief against the rich color tones of these windows, a beautiful piece of work in French limestone, the pinnacles shooting up like delicate ice crystals. When at a distance we see the figure of the Lord through the central opening in the altar, while close to the altar this is not impressive. On the right of Christ stands Peter, on the left Paul. This white altar contrasts finely with the dark oak of the seats arranged on the sides. The chancel, the seats and the organ loft are in the same tone.

The exterior of the church is as imposing as the interior is harmonious. Here we have the old stones of the walls built in the time of Frederick the Wise, and all additions, such, for instance, as the sacristy, have been built in the same style. The burned wooden wings of the Thesis Door were replaced in 1858, by order of Frederick William IV., the new doors bearing the Latin text of Luther's "Theses." This celebrated main entrance is marked by the slender louvre tower vertically above the transept. The principal tower on the northwest corner is very peculiar, and its unusual form shows that it was not always a church tower. In fact, it belonged, in earlier times, to the castle, and later it was several times connected with and disconnected from the church. But this castle tower in connection with this house of God has its special significance, which finds expression in the scroll in the cornice on which the large Gothic letters in mosaic glass work form the words "Ein fester Burg ist unser Gott, ein gute Wehr und Waffen!" (A mighty fortress is our God, a bulwark never failing). This tower, which is 288 ft. high, always attracts the attention of the observer, and when, on October 31, its bells invited to the third consecration, and all the bells of the country round answered in a festal chorus, it was a happy day, not only for Wittenberg, but for all evangelical Christians in Germany and abroad.

In the dedicatory sermon which Luther preached in the church one year before the writing of his "Theses," he reminded his hearers that a consecration of the church should also be a consecration of the heart. Let us hope that the admonition was kept in mind by the congregation during this last ceremony.

For the above and for our larger illustration we are indebted to the *Illustrirte Zeitung*, and for the other illustrations to the *Illustrated London News*.

On Monday, Oct. 31, 1892, says the *Illustrated London News*, the anniversary of Luther's memorable act in 1517, when he affixed to the door of the Schlosskirche at Wittenberg his written "Theses" or theological propositions contradictory of the doctrines of the Roman Catholic Church, a ceremony of great interest to the German Protestants was performed in the presence of the Emperor William II., King of Prussia. This was the reopening and renewed dedication of the Schlosskirche, which has, during seven years past, been undergoing a complete architectural restoration, at the cost of the Prussian government, promoted by the Emperors William I., Frederick III., and William II. In the year 1883, a few weeks previously to the celebration, on Nov. 10, of the four hundredth anniversary of Luther's birth, the Imperial Crown Prince Frederick William, afterward the Emperor Frederick III., visited Wittenberg to open the Luther Hall at the University, with the apartments, including Luther's study, occupied by the great reformer when he was university professor there. The Schlosskirche, containing the tombs of Luther and Melancthon, has been restored from the designs and under the supervision of Professor F. Adler, of Berlin, "Geheime Oberbaurath," by the government architect Herr Paul Groth. The tower has been entirely altered from what it was in 1883, being now raised to the height of 288 ft., instead of 100 ft., and its upper part adorned with a splendid circlet or frieze of mosaic, bearing an inscription in yellow letters on blue, and with a cupola and copper spire, richly ornamental. The Emperor and Empress, at the opening ceremony, were accompanied by the Crown Prince of Sweden, the Duke of York, and representatives of all the Protestant German states.

MULTIPLICATION SIMPLIFIED.

By NICHOLAS J. VANDER WEYDE, C.E.

Is the tendency of modern advancement in the direction of simplification or are we striving after more complicated methods of doing? May we not modify the elaborate processes of our forefathers and make life easier for our posterity? Must conservatism block the way to progress in arithmetic as well as in spelling and in weights and measures?

While the author of this article has been endeavoring to make the path of elementary arithmetic easier to the learner, by simplifying the process of multiplication, a puzzle fiend of the periodical order has invented, patented and caused to be published an arithmetical puzzle for cranks of mathematical tendencies to rack their brains over and perhaps wreck their intellects on. If the former can save his fellow creatures as much worry and exasperation as the latter has been the cause of, he will not feel that his labors in perfecting and introducing this new method have been in vain.

Arithmetic is acknowledged to be one of the most interesting branches of elementary education, and if the tedious processes hitherto necessary for obtaining required results can in any way be modified, a decided gain will have been achieved in the saving of time and patience of those giving as well as receiving instruction; and the mental worry incident to a constant liability to error will be greatly obviated by a less complicated process than that of "old style" multiplication.

Let the brilliant and fascinating "Algebra" come to the rescue of her well meaning but often misunderstood younger sister "Arithmetic" with the easily proved and convincing formula that "*the square of the sum of two numbers is equal to the square of the first, plus twice their product, plus the square of the second.*" Algebraically and arithmetically expressed, with $x = 40$ and $y = 6$, making $x + y = 46$, we have

$$\begin{array}{lcrcr}
x + y & = & 40 + 6 & = & 46 \\
x + y & = & 40 + 6 & = & 46 \\
\hline
x^2 + xy & & 1600 + 240 & & 1600 \\
\quad + xy + y^2 & & 240 + 36 & & 480 \\
 & & & & 36 \\
\hline
x^2 + 2xy + y^2 & = & 1600 + 480 + 36 & = & 2116
\end{array}$$

but it is more convenient to do all the squaring first and the cross multiplying (doubled) afterward, of which two examples are given below:

```
 4 6²              3 9 5 1²
------          -------------
1 6.3 6         0 9.8 1.2 5.0 1
  4 8             5 4.9 0.1 0
------              3 0.1 8
2 1 1 6               0 6
                -------------
                1 5 6 1 0 4 0 1
```

The advantage of squaring by this method can be readily appreciated. No more figures used than by the old method, much less chance of error and not nearly so much strained attention required to keep track of the operation.

Let us do the same thing with ordinary multiplication, with this difference, that while we multiply every figure in the multiplicand by every figure in the multiplier, we do not double any of the products, but put them all down as shown in the following examples:

```
  3 7               8 5 6
  9 5               9 1 4
-------           -----------
2 7.3 5           7 2.0 5.2 4
  6 3               4 5.0 6
  1 5               0 8.2 0
-------               5 4
3 5 1 5               3 2
                  -----------
                  7 8 2 3 8 4
```

Where the number of figures in the two factors is not the same it is only necessary to prefix one or more ciphers to the lesser and proceed as before:

```
      4 7 9 3
      0 2 5 6
---------------
0 0.1 4.4 5.1 8
  0 0.1 8.1 5
  0 8.3 5.5 4
    0 0.0 6
    2 0.4 2
      2 4
---------------
  1 2 2 7 0 0 8
```

If a line of products is going to be all ciphers, viz., 0×3 in above example, it may be omitted as in "old style" multiplication, and if decimals are involved, the decimal point finds its place by the old rules.

The process just described and illustrated might be known as "long multiplication" and should be taught first; but where the number of figures in the multiplicand far exceed those in the multiplier, another process, to be known as "short multiplication," will be found more convenient and practicable. In the following example the work is left unfinished in order to show its progress, and the annexed "process" example illustrates how it is done, the products being put down on the first and second lines alternately.

```
 4 8 9 3 1 8 5                   PROCESS.
 7                        7 × 4, × 8, × 9, × 3, etc.
---------------           ---------------------------
2 8.6 3. etc.             7 × 4, 7 × 9, etc.
 5 6.2 1                         7 × 8, 7 × 3
```

It will be noticed that the products are put down alternately on the first and second lines, so that the units will come in consecutive places.

The part of the process of multiplication most liable to error is that of carrying the tens when the units are put down. In the new way everything is put down and there is no carrying until all the products of multiplication are being added together. In order to check any tendency to carry the tens, the multiplication is begun at the left hand end, but the adding is done from right to left as in the "old style." The following is a finished example worked out according to this idea:

```
  7 4 9 8 4 3 1 0 9
  3 9
-----------------------
2 1.2 7.1 2.0 3.2 7
  1 2.2 4.0 9.0 0
  6 3.8 1.3 6.0 9.8 1
    3 6.7 2.2 7.0 0
-----------------------
2 9,2 4 3,8 8 1,2 5 1
```

Below is the same example worked out according to the "old style," with the mental part of the process fully illustrated:

```
    7 4 9 8 4 3 1 0 9
                    3 9
  ---------------------
  6 7 4 8 5 8 7 9 8 1
    4 8 7 3 2 0 0 8    *
2 2 4 9 5 2 9 3 2 7
  1 2 2 1 0 0 0 2      *
  ---------------------
2 9 2 4 3 8 8 1 2 5 1
```

The small figures in a line with the asterisks are the tens to be carried. As a rule they are never put down, but have to be remembered and considered all the same. Should the attention be distracted during the process, a carried figure may be forgotten and time lost in going back to find it. Arithmeticians of the present age are so familiar with the old style and are so used to its workings that it would be unreasonable to expect them to take up the new; but the new style is for those to whom arithmetic is new, and for them it cannot fail to be simpler, easier and quicker than the other. It may necessitate putting down a few more figures on paper, but it certainly saves putting them down in the brain. Any unnecessary tax on the memory, either for short or long periods, is nothing more nor less than the mental carrying of so much dead weight.

In the new style each product is put down complete, the tens and units falling naturally into their proper places, representing, units, tens, hundreds, thousands, etc., according to location. The separating dots used in the examples given are only intended to keep each product by itself, and may be dispensed with in the regular and practical use of the process. The readiness with which examples can be corrected or their correctness verified by either pupil or teacher is in itself a vast economy of both time and labor in education, as errors are detected in any part of the operation without going back for missing or mistaken tens. The author of these pages is confident that there can be no further use for the "old style" multiplication, either in school, in college or in business, which the new style cannot fill to greater advantage.

In conclusion it may be well to remark that if this easier method of multiplication is not new, a most unjust and iniquitous tax has been levied on the energies of the children of the present century, in not introducing it before into the primary schools of the civilized world. The new method is easy enough to teach, simple enough to understand and convenient enough to use in all the operations of practical mathematics for it to entirely supersede the "old style" in the schools of this country by the beginning of the twentieth century.

OSMOTIC PRESSURE.

By J. W. RODGER.

OF the various properties which have found a common explanation in the new theory of solutions, there are none perhaps to which more interest attaches than to osmotic pressure; and although, on account of the experimental difficulties, the observations as yet accumulated on this subject are but scanty, they have so largely contributed to the novel ideas involved in the new theory that they merit special attention.

Since accounts of osmotic pressure are finding their way into few English text books, it may be worth while glancing at the main features which have led up to the present state of the question.

It has long been known that if an aqueous solution —say of sugar—be separated from pure water by a piece of animal membrane, movements of the water and of the sugar take place through the membrane. If the solution be contained in an open vessel, the base of which is composed of membrane, on partially immersing the vessel in water it is easy to see that more water enters the vessel than solution leaves it. The level of liquid within rises above that without the vessel, different pressures being thus set up on opposite sides of the membrane.

To this process wherein currents pass through a membranous septum, the terms "osmosis," "osmose," and "diosmose" have been applied. The last of these is perhaps to be preferred, as it serves to indicate that two currents are involved in the phenomena. Investigations carried out as indicated above were concerned with the measurement of what was termed the "endosmotic equivalent." That is the ratio of the amount of water passing *into* the solution to the amount of dissolved substance passing in the opposite direction. Consistent measurements of this quantity could not be obtained, however, for it was found that the nature of the membrane exercised a marked influence upon its magnitude. The kind of membrane employed, or, with the same membrane, its thickness or freshness, or even the direction in which water passed through it, was of importance. Thus, in illustration of the last point, water passes more readily outward through eel's skin, more readily inward through frog's skin.

To obtain quantitative relations in this field it thus became essential to eliminate the influence of the membrane, and more recently this end seems to have been attained by the use of membranes artificially prepared.

These artificial membranes differ from those of animal origin in the remarkable particular that although they allow water to pass through, they present a barrier to the passage of certain dissolved substances. On this account they have been termed semi-permeable membranes, and by their use measurements of osmotic pressure have been made possible.

To carry out such measurements the first point to be solved was to obtain a membrane of sufficient strength. The substance which has been found to be most satisfactory as a membrane former is copper ferrocyanide. When aqueous solutions of potassium ferrocyanide and copper sulphate are carefully brought into contact, a pellicle of copper ferrocyanide is formed where the two solutions meet. In this condition the pellicle is much too fragile to sustain even slight differences of pressure; but by the following simple device, employed first of all by W. Pfeffer, satisfactory results have been obtained.

If a cell similar to the ordinary porous pot of a voltaic battery be lowered into a solution of copper sulphate while at the same time a solution of potassium ferrocyanide be poured into its interior, the two solutions meet somewhere within the walls of the cell and deposit a film of copper ferrocyanide. Little diaphragms of membrane are thus produced stretching across the pores of the cell wall, which furnishes the necessary support, and by taking suitable precautions a membrane may thus be obtained capable of withstanding a pressure of several atmospheres.

The behavior of a solution when separated from pure solvent by such a semi-permeable membrane differs markedly from what takes place when an animal membrane is employed. In the latter case, at the outset, water adds itself to the solution; the level of liquid

and the pressure on the solution side of the membrane thus rise until a maximum pressure head is attained, which, roughly speaking, is greater the stronger the solution used. Seeing, however, that dissolved substance is continually escaping from the solution through the membrane, as soon as the maximum is reached the pressure head begins to fall, until eventually it vanishes, the levels of liquid on either side of the membrane being the same.

If, on the other hand, a semi-permeable membrane be employed, as before, a maximum pressure is attained; but since dissolved substance cannot leave the solution, this maximum pressure as well as the concentration of the solution remain constant.

When this constant state of things is established the excess of pressure on the solution side of the membrane over that on the solvent side, whatever it may mean, is termed the "osmotic pressure" of the solution. It is therefore customary to reserve the term osmose to phenomena relating to semi-permeable membranes, diosmose being used in cases where, as with animal membranes, dissolved substance as well as solvent can traverse the membrane. It is obvious that when the pressure is established as indicated above, the original concentration of the solution has been altered by the entrance of solvent, and the observed osmotic pressure refers, of course, to the solution having the final concentration. If, however, we imagine the vessel containing the solution to be closed at the top, a quantity of air being imprisoned over the solution, pressure may be set up by compressing this air, only a small quantity of solvent being allowed to enter. If, further, the air inclosure be tapped by a manometer, measurements of the pressure may be taken, and by making the air inclosure and the volume of the manometer small enough the quantity of solvent entering while pressure is being established may be neglected, the original concentration of the solution remaining practically unaltered. This is the principle of the method employed in measuring osmotic pressure in absolute units.

The question now arises, "Are these measurements really independent of the nature of the membrane? Has the difficulty which beset the older experiments been overcome?" To this question an immediate answer is forthcoming, for, as pointed out by Prof. Ostwald, it follows from theoretical considerations that if the membrane employed is really semi-permeable, the observed osmotic pressure of a given solution must be the same, no matter of what material the membrane is composed. For, suppose we have a quantity of solution inclosed in a tube, one end of the tube being closed by a membrane, A, the other by a membrane, B, and suppose it possible that a pressure, P, can be developed on the membrane, A, when it separates the solution from pure water, which is higher than the pressure, *p*, similarly developed, when B separates the solution from pure water. On immersing the tube in water, the latter will begin to pass through both membranes into the solution. When the pressure, *p*, is attained passage through B will stop, but that through A will continue; but as soon as the pressure on the solution rises above *p*, water will be forced out through B. The pressure, P, will thus never be attained, water will continuously enter through A, and pass out at B. We will thus have a machine capable of doing an infinite amount of work, which is impossible. Similar reasoning shows that *p* cannot be greater than P; it follows therefore that the pressure developed on each membrane is the same, that the osmotic pressure must be independent of the nature of a truly semi-permeable membrane.

Actual observations are on record in which the osmotic pressure did appear to vary with the membrane employed. A sugar solution, for example, exhibited a much lower osmotic pressure with a membrane of Prussian blue or calcium phosphate than with copper ferrocyanide. From the preceding argument it is concluded, however, that these membranes giving the lower values were not quite firm or not quite impermeable to the dissolved substance; the highest value is thus taken as the measure of the osmotic pressure which is nearest the truth.

On glancing at the results which have been obtained, the first point which strikes one is the extraordinary magnitude of the pressures thus set up. In the case of a 1 per cent. aqueous solution of niter, the pressure attains the value of $2\frac{1}{2}$ atmospheres. This value increases with the strength of the solution till at 3·3 per cent. it is no less than 6 atmospheres, this pressure being the highest which any membrane yet prepared has been able to withstand. With substances like sugar, other things being the same, the pressure is not so great, but in all cases, in order to keep it within workable limits, the solutions employed have to be dilute.

Striking as the results are themselves, their explanation is not less remarkable. The original measurements of osmotic pressure were made with the purpose of elucidating the movement of liquids in plant cells, and naturally the substances examined were such as occur in the vegetable organism—aqueous solutions of sugar, gum, dextrin, and the nitrate, sulphate and tartrate of potassium. For some years after these observations were made, they lay comparatively unnoticed, until Prof. van't Hoff, of Amsterdam, turned them to a use undreamed of by their discoverer. From a study of the properties of dilute solutions van't Hoff came to the conclusion that the osmotic pressure was due to the bombardment of the molecules of the *dissolved substance* on the semi-permeable membrane. For when the osmotic pressure is established and equilibrium exists between solvent and solution, in the same time, equal amounts of solvent must pass in either direction through the membrane and the impacts of the solvent molecules on the membrane will then be equal and opposed on either side, and therefore negligible. On this reasoning the pressure recorded on the manometer is taken to be that exerted by the substance in solution.

On examining the magnitude of the pressure thus attributed to the dissolved substance, in the case of a solution of sugar, van't Hoff next showed that it bore the closest resemblance to the pressure of a gas. Indeed, if we calculate the pressure of a gas which at the same temperature contains as many molecules per unit volume as there are molecules of sugar per unit volume of solution, then the pressure of the gas and the osmotic pressure are the same. Moreover, on thermodynamical grounds it was established that on the above hypothesis as to the nature of osmotic pressure its magnitude should be quantitatively connected with measurements of other physical properties of solutions, more especially those on the lowering of the vapor pressure, and of the freezing point of a solvent produced by the presence of dissolved material. In this way a mass of evidence was collected, a general survey of which led to the foundation of the new theory of solutions. On this theory the dissolved substance, if the solution be dilute, is supposed to behave as if it were gaseous, the pressure it exerts—the osmotic pressure—being equal to the pressure which it would exert if it were gasified, and occupying, at the same temperature, a volume equal to the volume of the solution.

Unfortunately measurements of osmotic pressure have only been made on few substances, and only for solutions in water, but on turning to all the available observations to see how they support this novel conclusion, the most superficial examination serves to show that an agreement does not exist. Unless in the case of sugar, for no substance of known formula which has yet been investigated does the osmotic pressure agree with the corresponding gaseous pressure. These substances consist of salt solutions, and they invariably give higher osmotic pressures than theory demands. Similar disturbing influences have been observed when other physical properties of these solutions were measured, and to account for the facts an additional hypothesis has been put forward by Dr. Svante Arrhenius.

Salt solutions are electrolytes, they conduct the electric current, and undergo simultaneous chemical decomposition into their constituent ions. Experiment shows that such electrolytic solutions give high osmotic pressures, more particles appear to bombard the semi-permeable membrane than if the dissolved substance behaved as a gas. The new hypothesis states that this is really the case, the additional number of particles being produced from the breaking up of the dissolved substance. It states that in a solution which can be electrolyzed a portion at least of the dissolved substance exists already decomposed or dissociated into its ions, and that although these ions cannot be separated by diffusion, they are so far independent that each can exercise an effect on the semi-permeable membrane.

The extent of this electrolytic dissociation is supposed to vary with the chemical nature of the dissolved substance, and to increase with the dilution. In very dilute solutions it may be complete, the whole of the dissolved substance being supposed to exist in the state of ions.

The second hypothesis gives, therefore, some explanation why the osmotic pressure of a salt solution is greater than that of a non-electrolytic solution of sugar; it further fixes the limits between which the osmotic pressure ought to vary in the case of an electrolyte, for the lower limit should be that of undissociated gas, the higher should be that of completely dissociated gas, each original molecule having decomposed into as many sub-molecules as there are ions in each molecule of salt.

So far as these limiting conditions go, the facts support the hypothesis. In all cases the observed osmotic pressure is either equal to one or other of the limits, or lies between them. A closer scrutiny leads, nevertheless, to apparent discrepancy. It is evident that a measure of the amount of dissociation can be obtained from osmotic pressure observations. For if we divide the observed osmotic pressure by the corresponding pressure of undissociated gas, we have obviously, if the preceding hypotheses are valid, the ratio of the actual number of bombarding molecules to the theoretical number had no dissociation occurred. The ratio of these two numbers is denoted by the letter "*i*," a factor first used by van't Hoff. Now, on the new theory, the value of "*i*" can be obtained by measurements of other properties of salt solutions, the electric conductivity, the depression of the freezing point, etc., and the theory is compared with practice by seeing if the values of "*i*," as determined, say from freezing point observations, agree with those deduced from the osmotic pressure. The comparison shows that in some cases, some half a dozen in all, the two sets of values correspond; in others, and in by far the majority, no such correspondences exist. In these latter instances it is argued, and with a certain amount of experimental evidence, that the salts were not without action on the membrane employed, and that, therefore, diosmose really took place, the membrane was not truly semi-permeable. In this way the discordant observations have been put out of court.

It is thus apparent that the leading hypotheses of the new theory do not receive confirmation of the weightiest kind from observations on osmotic pressure. Indeed, were they supported by such measurements alone, they would hardly be entertained. Their mainstay, however, lies in the mass of experimental work on many other properties—evidence which it is much easier to obtain than the difficult measurements on osmotic pressure—which has been correlated and explained by their use.

It is only fair to add that both hypotheses, from physical as well as chemical standpoints, have met with a measure of adverse criticism. The *role* played by the membrane has also been questioned. It has been suggested that it is not really semi-permeable, allowing solvents only to pass, but just as a porous plug behaves toward a mixture of gases, it allows molecules with different momenta to traverse it at different rates. Or, again, its action has been likened to that of a palladium film toward hydrogen, compounds being formed with the membrane substance on one side, these becoming diffused and dissociated on the other. If either of these views be correct, the pressures exerted by dissolved substances have probably never been measured.

On the other hand, important theoretical support has been put forward in favor of the gaseous analogy. Several physicists, starting from entirely different points of view, have arrived at the result that in a dilute solution the dissolved substance should obey laws similar to those which hold for gases. At present the attitude of the prominent upholders of the new theory is one of indifference as to the exact mechanism of osmotic pressure. The numerical agreement between the measurements on solutions and those on gases is regarded as ample justification for considering dissolved substances to be in a *pseudo*-gaseous condition.

Whatever the ultimate explanation of the facts may be, there can be no doubt that the existing speculations on the nature of osmotic pressure and allied phenomena have infused new life into the study of solutions. Indeed, as instigators to fresh inquiry these hypotheses must take rank as the most fruitful of recent times.—*Nature.*

A BOTANIST IN THE HAWAIIAN ISLANDS.

A RECENT number of the American *Botanical Gazette* contains a paper by Prof. D. H. Campbell, describing his experiences during a vacation spent last summer in the Hawaiian Islands. We quote the following:

On awakening upon the seventh day out, and looking through the port hole of my state room, I saw that we were sailing near land. Rugged barren looking hills were seen, and going upon deck, I learned that this was Oahu, the island upon which Honolulu is situated. As we skirted the shore at a distance, I soon spied a grove of unmistakable cocoa palms, the first hint of the tropical vegetation to which I was soon to be introduced. Beyond was the bold promontory of Diamond Head, an extinct volcanic crater, forming a great bowl with rugged sides, right at the water's edge. Beyond this, and bounded partly by it, is the bay upon whose shores stands the city. Back of it rose abruptly a chain of mountains, in places about three thousand feet above sea level, and furrowed by deep valleys, whose walls, as well as the cloud-capped summits of the hills, were covered with the most wonderfully verdant vegetation. Never before had I realized the possibilities of green. Blue greens, yellow greens, gray greens, and positive greens, with all degrees of these and others that are indescribable, combined to form what Whistler would term a symphony in green.

As if to vie with the colors of the mountains, the sea exhibited an equally wonderful variety of tints. Outside the harbor is a coral reef, and within this the water is of the pale green common to shallow ocean water; but outside it deepens very rapidly into the vivid blue of the open ocean. From a distance the line is clearly seen, but as the observer approaches shore, the water changes from deep blue through every shade of blue and green until the pale green of the water within the harbor is reached.

As we approached land, numbers of the queer outrigger canoes of the natives were met, and from the wharf boys jumped into the water and swam about the ship in the hope of persuading some of the passengers to throw over to them coins, which they were very skillful in diving for.

On the way to the hotel a few gardens were passed, and in them everything was strange. By far the most striking thing was the superb *Poinciana regia.* Although I had never seen this before, I recognized it in an instant from a description of Charles Kingsley's, read long ago. Surely in the whole vegetable kingdom there is no more splendid plant. A spreading flat-topped tree, perhaps thirty feet high, with feathery green, acacia-like foliage and immense flat clusters of big flaming scarlet flowers that almost completely hide the leaves, so that the tree looks like an immense bouquet. They were in their prime about the time of my arrival in Honolulu, and continued to flower more or less for the next six weeks. Pretty much everything in Honolulu except the cocoanuts and an occasional haw tree (*Paritium tiliaceum*) is planted; but people seem to vie with each other in seeing how many different kinds of plants they can grow, and the result is that the place is like one great botanical garden. To Dr. Hillebrand this is said to be largely due, as he was one of the first to introduce foreign ornamental plants, and his place, which is kept much as it was at the time he left the islands, was a very remarkable collection of useful and ornamental plants from the warm regions of almost the whole globe.

Probably the first thing that strikes the traveler from the cooler regions is the great variety and number of palms. Of these the beautiful royal palm (*Oreodoxa regia*) is easily first. With its smooth columnar trunk, looking as if it had been turned, encircled with regular ring-shaped leaf scars, and its crown of plumy green leaves, it well deserves its name. Other characteristic palms are various species of betel palms (Areca), wine palm (Caryota), sugar palm (Arenga) and a great variety of fan palms of different genera. None is more beautiful than a thrifty young cocoa palm, but unfortunately it is very subject in the Hawaiian Islands to the ravages of some insect which eats the leaves and often renders them brown and unsightly. Indeed, it is almost impossible to find a specimen which is not more or less disfigured by this pest. The trunk of the cocoanut tree is usually more or less crooked, and in old specimens much too tall for its thickness, so that the old trees look top-heavy. The date palm flourishes in Honolulu, where it is quite dry, but does not do so well in the wetter parts of the islands.

On studying the other trees, one is struck at once by the great preponderance of Leguminosæ, especially Cæsalpineæ and Mimoseæ. All about the town, and growing very rapidly, is the algaroba (*Prosopis juliflora*), a very graceful tree of rapid growth, with fine bipinnate leaves and sweetish yellow pods, which animals are very fond of, and which are used extensively for fodder. Add to this that the tree now forms the principal supply of fuel for Honolulu and we can realize its full value. Other leguminous trees that are planted are the monkey pod (*Pithecolobium samang*), tamarind, various species of Bauhinia and Cathartocarpus. One species of the latter with great drooping bunches of golden yellow flowers and enormous cylindrical pods three or four feet long rivals the Poinciana when in full flower.

Mingled with these are a great number of shrubs and trees with showy flowers or leaves, most of them more or less familiar to the stranger, either from pictures or from greenhouse specimens. Several species of Musa are grown, and when sheltered from the wind are most beautiful; but ordinarily the leaves are torn into rags by the wind. The tall and graceful *M. sapientium* has been largely supplanted by the much

less beautiful Chinese banana, *M. Cavendishii*, which is short and stumpy in growth, but enormously prolific. The related traveler's tree (*Ravenala Madagascariensis*), is a common and striking feature of many Hawaiian gardens. Of the many showy flowering shrubs, the beautiful *Hibiscus Rosa-Sinensis* is one of the commonest, and is used extensively for hedges. One of the most striking hedges in the city, however, is the famous one at Puna Hou college, which is 500 ft. long and composed of night blooming cereus. I was not fortunate enough to see this when it was in full flower, but I saw a photograph of it when it was estimated that there were about 8,000 flowers at one time.

Of the fruit trees ordinarily grown, the following may be mentioned. The mango is a very handsome tree with dense dark green foliage and masses of yellow and reddish fruit on long hanging stalks. The bread-fruit tree is common, both cultivated and wild, and is a very beautiful tree of moderate size, with leaves looking like immense fig leaves, and the fruit like a large osage orange. I saw no ripe fruit, and so had not an opportunity of testing its quality. Guavas of different varieties are extremely common, both wild and cultivated, and the various fruits of the whole citrus tribe grow well. The few specimens of temperate fruits were, for the most part, much inferior to those of the United States. Of the fruits that did not strike my fancy, at least at first, was the alligator pear (*Persea gratissima*), a big green or purple pear-shaped fruit with an immense single seed. The pulp is somewhat waxy in consistence and very oily. It is eaten as a salad, and very much relished by the islanders, but the taste is acquired. The curious papaya (*Carica papaya*) is another fruit which did not appeal to my palate. Its big orange fruit, not unlike a melon in appearance when cut open, has a peculiar "squashy" flavor that suggested its having been kept a day too long.

Many showy climbers are planted, some of which, like the stephanotis, thunbergia, and allamanda, are superb; but there is one that is particularly obnoxious in color, bougainvillea, whose magenta floral bracts are an offense to the eye, forming a cataract of raw color. It looks, as some one observed, as if it had just come from a chemical bath.

As soon as one gets fairly away from the city, it is at once seen that all the luxuriant vegetation is strange. Along the seashore is a plain gradually rising into low hills, both almost destitute of trees, except here and there a few cocoa palms along the shore. Of the strictly littoral plants, among the most conspicuous is the curious *Ipomœa pes-capræ*, with deeply two-cleft leaves and purplish pink flowers. In the fertile lowlands near the sea are the principal cane and rice fields, which with taro are the staple crops. The rice is cultivated entirely by Chinese, near Honolulu; but on the sugar plantations the Japanese are largely employed. To see a Chinese laboriously transplanting little handfuls of rice into straight rows, or plowing in the mud and water with a primitive plow drawn by a queer Chinese buffalo, are sights very foreign to an American eye. Sugar cane is eminently productive in the islands, and, hitherto, has proved the main source of revenue; but now the Hawaiians are bewailing the depression caused by the free admission of sugar from other countries into the United States; as, hitherto, their product has enjoyed practically a monopoly of the American market, having been admitted by treaty free of duty.

I made several trips up the valleys back of the city, but owing to the almost constant rain in many of them, these were not always agreeable. However, one is richly repaid by the luxuriance and variety of the vegetation. For a mile or two we pass between grass-covered hills, or hills overgrown in places with the lantana, which, introduced as an ornamental plant, has become a great pest. This plant covers some of the hills with an absolutely impassable thicket, and spreads very rapidly, so that it is a serious problem what is to be done with it. Of the common roadside plants, an orange and yellow milk weed and the showy white *Argemone Mexicana* were the most conspicuous. As one proceeds farther, where more moisture prevails, the variety becomes larger. Thickets of Canna and a Clerodendron, with double rosy-white flowers, are common, and the curious screw pine (*Pandanus odoratissimus*) is occasionally seen. This latter is a very characteristic plant, but is much more abundant in some of the other islands. In this region some very showy species of ipomœa are very common, among them the well known moon flower, *I. bona-nox*.

With the increase in moisture, as might be expected, the mosses and ferns increase in number and beauty. There are many of them of types quite different from those of the United States. One of the commonest ferns of the lower elevation is *Microlepia tenuifolia*, a very graceful fern with finely divided leaves and terminal sori. Species of Vittaria, with very long undivided leaves, are also common here.

As we ascend, one of the commonest ferns is *Sadleria cyatheoides*, a very large fern, often more or less arborescent. Ascending still higher, the number and variety of ferns increases rapidly, and many beautiful and interesting ferns and mosses and liverworts become common.

At about one thousand feet elevation we begin to meet with species of Cibotium, to which genus belong the largest of the tree ferns of the islands. Here, also, I met for the first time with the smallest of all the ferns I have ever seen, *Trichomanes pusillum*. This dainty little fern, one of the Hymenophyllaceæ, forms dense mats on rocks and tree trunks, looking like a delicate moss. The fullgrown frond is fan shaped, and, with its stalk, is not more than half an inch high. These tiny leaves, nevertheless, in many cases bore sporangia.

GRASSHOPPERS, LOCUSTS AND CRICKETS.

THE New Jersey Agricultural College Experiment Station Bulletin 90, by John B. Smith, entomologist, is devoted to these insects, and especially to an examination of their supposed depredations upon the New Jersey cranberry beds. We make the following abstracts. He attributes the bulk of the injury to those locusts commonly known as katydids.

The katydid (*Scudderia*) crops were full of undoubted cranberry seed fragments, while in the two species of *Xiphidium* grass tissue only was found.

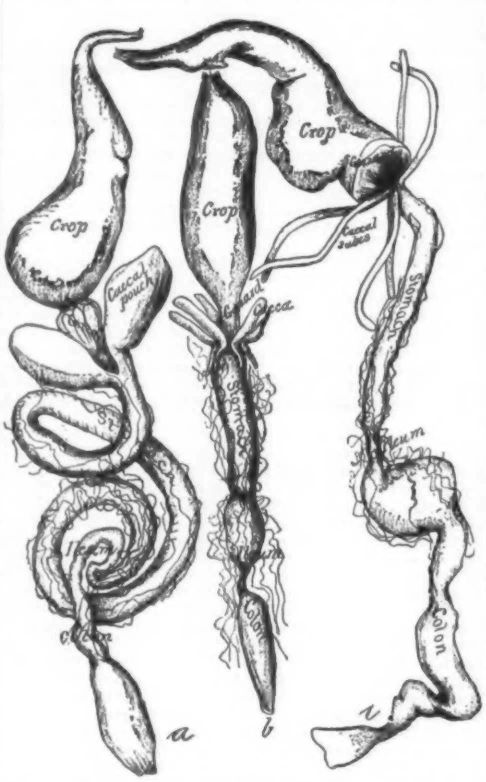
The Acrididæ, or short-horned grasshoppers, do very little, if any, of the injury to berries on the cranberry bogs, while of the Locustidæ, or long-horned grasshoppers, the katydids are the main culprits, aided occasionally by a species of *Orchelimum*.

The injury on cranberry bogs is always the same. The berry is eaten into from one side, the pulp is rejected and only the seeds are taken. The berry soon dries and shrivels up. The very fact that there is no variation in the injury points to the conclusion that only one or a few very closely allied species can be responsible for it, because it would be a decidedly unusual thing for insects of different families, differing also anatomically, to have so exactly the same food habits.

The remedies recommended are clean bogs, ditches surrounding the bogs, clean cultivation, use of nets to catch the insects.

In insects generally the digestive system begins with a narrow tube from the mouth, called the œsophagus, opening into a large pouch or crop, capable of great dilation, into which the food is crowded while the insect is eating. At or near the mouth opening are the salivary glands, secreting an often colored or acrid liquor, which is sometimes also defensive in character, and in the grasshopper produces the so-called "molasses." From the crop the food passes more slowly into the gizzard, where it is further ground up, and passes into the true stomach or chylific ventricle. At the entrance of this stomach certain glands, tubes, or pouches are situated, which secrete a digestive fluid that mixes with the food as it passes in and facilitates assimilation. These are called cæca, or cæcal tubes or pouches, and they serve also, in some cases, to afford a greater digestive and assimilative surface. Beyond this stomach comes the ileum or small intestine, in which absorption is continued, and beyond that we have the colon or large intestine, in which the residue of the food not needed by the animal is prepared to be excreted through the rectum.

Surrounding the stomach are numerous long and



Alimentary canal of *a*, katydid (*Scudderia furculata*); *b*, grasshopper (*Acridium obscurum*); *c*, cockroach (*Blatta orientalis*), much enlarged. All the parts of the tract are named, except the irregular threads surrounding the stomach, which are the Malpighian vessels. They are much more numerous than shown in the figure, and form, in nature, a complete network around the organ.

slender tubular threads, supposed to be excretory in character, and called Malpighian vessels.

In the order *Orthoptera*, the digestive system agrees with this general type, but is distinctively developed in each family. In the grasshoppers the entire digestive canal is nearly straight, passing from the mouth to the opposite extremity without convolution and with but a slight curve. The crop is of good size, quite muscular and tough, and shows, when split open and cleaned, numerous transverse wrinklings and ridgings, gradually changing to a longitudinal form, and these in turn break up into little conical teeth toward the end of the crop, to change again to a plate-like structure at the constriction before the opening into the stomach.

There is no distinctly developed gizzard, the end of the crop performing the functions of that organ. The stomach is not greater in length than the crop, and is much narrower, so that one cropful will make at least two stomachfuls. The small intestine is very short and the large intestine is not much longer. Altogether the crop has a greater capacity than the remainder of the alimentary canal. The cæcal tubes at the mouth of the stomach are six in number, and are very well developed, extending, pouch-like, upward along the crop, and, tube-like, downward along the stomach.

The katydid digestive system is quite different. The œsophagus is quite long, where in the grasshopper it is very short, and the crop lies in the abdominal cavity, instead of partly in the thorax. The crop itself is larger in the katydid, by nearly one-half, as compared with a grasshopper of approximately the same size. When split open it shows none of those peculiar ridgings so prominent in the grasshopper, but appears as a simple elastic, membraneous pouch, with a comparatively thin muscular coating. The gizzard, on the other hand, is very strongly developed. It is a distinctly dilated, though small, pouch, with thick muscular walls, the inner surface furnished with six series of complicated teeth in longitudinal plates, for grinding up the food passed from the crop. This is in strong contrast to the simple structure seen in the grasshopper, and indicates very much greater abilities in the food-grinding line.

Beyond the gizzard is the long stomach, coiled twice, and its capacity is two cropfuls, instead of only one-half a cropful, as in the grasshopper. The intestines, large and small, are also comparatively much larger. At the mouth of the stomach, instead of six cæcal tubes, there are two large pouches, overlying the gizzard, also crowded with food, and with a function probably much the same as that of the cæcal tubes. With such essentially different feeding and digestive systems, it would be strange indeed if both grasshoppers and katydids had exactly the same food habits. With the katydid type, all the locusts examined by me agree in essential points. The difference is in the armature of the gizzard, in which no two species are exactly alike. In the crickets the alimentary canal agrees closely with that of the locusts, and here, indeed, the armature of the gizzard is yet more complicated.

The roaches, though they are not to be particularly treated, may be mentioned as having a somewhat different digestive system from either grasshoppers or crickets. The crop is unarmed, as in the locusts, and the gizzard is well developed, having, however, a single series of six very large teeth, instead of the plates set with a series of small teeth. The stomach is only once coiled, and holds not more than a cropful, the small intestine is very short, while the large intestine is unusually long. The cæcal tubes are simple, very unlike the same structure in either grasshopper or locust.

This brief review of the feeding and digestive systems of the families of jumping Orthoptera indicates several matters quite strongly. It shows that the locusts and crickets have a very much greater capacity than the grasshoppers, and that they are as much more voracious and destructive. A katydid is able to stow away at one meal three times the quantity which can be eaten by our largest grasshopper. The complicated grinding apparatus in the gizzards of locusts and crickets shows that they are much better able to deal with hard substances, like seeds, than are the grasshoppers, who are furnished with a much simpler structure, though quite as efficient for softer textures. It is undoubtedly true that, when driven by hunger, few things come amiss to a grasshopper, even if we do not quite believe the stories of their eating off the edge of the scythes carelessly left out overnight; the structure simply indicates the *normal* habits.

Grasshoppers, locusts and crickets are nearly all capable of producing some kind of noise, musical or otherwise, but this ability is confined to the male. The faculty is least developed in the grasshopper, where a rattling, rasping or whirring sound is produced, either by rubbing the inner edge of the hind legs against the edge of the wing covers or by rubbing the edges of the two pairs of wings in flight. In the locusts the method is essentially different. At the base of the forewings is a small triangular area, where the wing covers overlap. In the male this area is tense, glassy and crossed by heavy veins, of which at least one is marked by transverse ridges. By the rubbing of these ridged veins a sound is produced, which is intensified by the glassy membrane acting as a sounding board, and thus results the loud "singing" of the katydids and softer note of the meadow locusts. The cricket has much the best developed musical apparatus. Here the wing covers overlap for nearly their entire width, and in the male this entire surface is transparent and tense. This gives a magnificent sounding board, and the effect is well known. The "cricket on the hearth" is famed in song and story, and its monotonous shrilling has lulled many a tired worker to sleep and has driven almost to distraction and banished rest from many a nervous subject.

THE BRINE SHRIMP OF THE GREAT SALT LAKE.

By J. E. TALMAGE, Ph.D., F.R.M.S., Salt Lake City, Utah.

THE brine shrimp, *Artemia fertilis* (Verril), is a tiny crustacean abounding in the water of the Great Salt Lake. They frequent the surface; indeed I have never taken a specimen from a depth beyond two feet. They may be found in the lake at all seasons, though they are most numerous between May and October. I have taken them in the midst of winter, when the temperature of the water was far below the freezing point; it will be remembered that the concentrated brine of the lake never freezes. The females greatly preponderate; in fact, during the colder months it is almost impossible to find a male. In the latter part of summer the females are laden with eggs, from four to sixteen having been repeatedly counted in the egg pouch. The males are readily recognized by the very large claspers upon the head.

The artemiæ frequent the shores during calm weather, but rain drives them into the lake. Oftentimes they congregate in such numbers as to tint the water over wide areas. They are capable of adapting themselves to great variation in the composition of the water, as must necessarily be the case with any inhabitant of the Salt Lake, for that body of water is subject to wide fluctuations in bulk and composition. Aside from the long periods of rising and falling of the waters, there are great annual variations caused by the relative supply of water through rain and snow-fall and the loss by evaporation. Besides the annual fluctuation, the lake is at present steadily falling, and the waters are consequently growing more concentrated. I have specimens of artemia gathered from the lake in September, 1892, and the water taken then showed on analysis 14,625·23 grains of dissolved solids to the imperial gallon, the greater part of this being salt. Indeed I have captured the creatures in the evaporating ponds of the salt works, where the brine was near its point of saturation. It is not difficult to accustom them to a diluted medium; I have kept them alive for days in lake water diluted with 25, 50, 80, and 90 per cent. fresh water, and from eight to eighteen hours in fresh water only. Of course the changes from brine to fresh water were made gradually.

As to their food, in captivity they live upon meat, bread, or vegetables, and in fact upon almost anything in the nature of food, and they are not slow in attack-

ing the bodies of their own dead. In the lake they probably subsist on the organic matters carried down by the rivers, upon the marine algæ which flourish about the shores, and upon the dead larvæ and the pupa cases of a fly which are found in the water in great numbers.

During a cruise upon the lake in September of the last year the crustaceans were found in great abundance. When near the middle of the lake, with a small tow net, we soon took a quart of the shrimps, and thereupon resolved upon an experiment the subsequent recital of which has shocked the gastronomic sensibilities of some of my dearest friends. Reasoning that the bodies of the artemiæ were composed largely of chitin, we concluded that the question of their palatability was at least worthy of investigation. By a simple washing with fresh water the excess of lake brine was removed, after which the shrimps were cooked with no accompaniments save a trifle of butter and a suggestion of pepper. They were found to be actually delicious. If the artemiæ could be caught and preserved in quantity, I doubt not they would soon be classed as an epicurean delicacy.

The mounting of the crustaceans for permanent microscopical use is by no means a simple undertaking, most of the ordinary media causing the delicate structure to become distorted, or producing such a transparency as to render the whole object invisible. The method which I now use is to mount them in a preparation of lake water, with corrosive sublimate and an alcoholic solution of carbolic acid. Into this fluid the living artemiæ are transferred directly from the lake brine; they die quickly, but in so doing spread themselves out most perfectly. By this method it is not always possible to get the mount free from foreign particles, but this is but a slight disadvantage. Before mounting I make a very shallow cell of hot paraffin and balsam, and after the cover glass is in position I ring the edge with a very little of the same material, following this with repeated layers of cement, King's preferred.

The popular literature of the day still declares that no living thing can exist in the Great Salt Lake. The perpetuation of this error is inexcusable. It is true, but very few species of animal life have been found in the concentrated brine of the lake, but some of these species there abound. Among the forms of life already reported as existing in the lake I have confirmed the presence of four: (1) the *Artemia fertilis* (Verril); (2) the larvæ of one of the Tipulidæ, probably *Chironomus oceanicus* (Pack); (3) a species of Corixa, probably *Corixa decolor* (Uhler); (4) larvæ and pupæ of a fly, *Ephydra gracilis* (Pack). Of the last named insect the larvæ are found in numbers near the shore, and the pupa cases in the spring and summer wash ashore in great numbers; there they accumulate, undergoing decomposition with powerfully odorous emanations.

Much has been said at different times as to the possibility of adapting fish to a life in the lake. In the absence of all experiment it would be rash to conjecture, though it would seem unlikely that fish could thrive in such a brine; but the fear expressed by some that, even if fish could be accustomed to the lake, they would starve, is unfounded; for certainly the food supply is abundant. The vegetable life of the lake is a subject worthy of investigation and one which at present is practically untouched.—*Amer. Micro. Jour.*

ON THE CAUSE OF EARTHQUAKES.

By the Rev. H. N. HUTCHINSON, B.A., F.G.S.

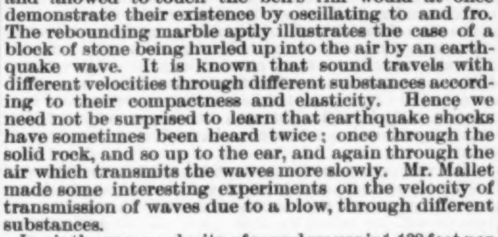
RECENT investigations have shown that *terra firma* is a phrase indicating a condition of things which, scientifically, has no existence. The crust of the earth is in a state of constant movement. Geologists have begun to study systematically the phenomena of earth movements of all kinds, and some of the results are such as cannot fail to interest even the general reader. We all have a stake in the condition of our planet. However, those who live in a region seldom visited by earthquakes are apt to overlook the importance of the subject. "Out of sight is out of mind," but as new methods of investigating and recording earth tremors, or throbs, are invented, these things are brought more prominently before us. Seismology, or the study of earthquakes, has lately been making great advances, and has revealed slight movements, the existence of which was previously unsuspected.

In view of these additions to our knowledge of an important branch of natural science, we propose to say a few words on earthquakes and earth tremors of all kinds, dividing the subject under three heads: (1) *What they are*, (2) *What they do*, and (3) *How they are caused.*

An earthquake has been defined by a high authority, the late Mr. Louis Mallet, as a wave or series of waves, of elastic compression, through the crust of the earth, in any direction, and from any given "center of impulse." To understand this definition, think of what takes place when a stone is thrown into a pool. A disturbance is made at the place where the stone strikes the water; that spot corresponds to the "center of impulse," the particles there communicating the movement to those next them, and these in their turn to others, and so on. In this way a series of concentric waves is produced, which get fainter and fainter, until finally they reach the edge of the pool. This is very similar to what happens when a subterranean disturbance gives a blow to the earth's crust, and a series of earthquake waves is produced from some seismic center. But, in both cases, the waves really travel in spherical shells. (See figure.) These waves, be it remembered, are due to wave motion, like waves of sound, and are by no means waves of translation. Each particle of earth merely moves as the ears of corn move in a field when they bend to the wind, and produce waves which travel across the field before the wind. It is clear that the undulatory movements due to an earthquake shock must strike the surface of the earth at different angles according to the distance of the seismic center. Thus, a person who might happen at the time to be standing on the spot, B, in a vertical line above such a center would feel an up and down movement, and a block of stone lying near him might be thrown straight up in the air; but if the person were some miles away from this spot, it is evident that the waves coming sideways would strike him to the ground he stands on obliquely, and "the angle of emergence" becomes less and less the further we recede from the spot lying just over such a center. Now, it is possible, by observing the effects of earthquakes on buildings, to determine the direction in which the shock arrived, and to calculate the "angle of emergence." This is done chiefly by studying the cracks produced in buildings, and making allowance for the circumstances of each case. If, then, this angle can be ascertained for two places, and the distance between them is known, a triangle is obtained, the base of which is known, and the angles at the base; hence it is easy to calculate the depth of the center of disturbance. Such calculations have been made in several cases, and the results arrived at are of considerable interest; for they tell us that in no case is the seismic center at a greater depth than thirty miles. In some cases the earthquake has been found to have originated at a much less depth. If these results are trustworthy, as there is reason to think they are, the conclusion is that earthquake phenomena are not connected with the deeper seated portions of the mass of the globe, but with those superficial portions commonly included in the earth's crust; and probably with the stratified series of rocks and their associated volcanic and plutonic rocks, rather than with the original mass which we believe to have solidified from a molten and highly heated state.

Earthquake waves can be measured, and it is found that they are quite small, having amplitude of perhaps only a few inches. The crust of the earth vibrating in response to a seismic blow may be compared to a big bell resounding after its inner surface has been struck by the clapper. In either case the amplitude of the vibrations is capable of measurement, but the undulatory movements are not visible as we look at a sounding bell, though a marble suspended by a string and allowed to touch the bell's rim would at once demonstrate their existence by oscillating to and fro. The rebounding marble aptly illustrates the case of a block of stone being hurled up into the air by an earthquake wave. It is known that sound travels with different velocities through different substances according to their compactness and elasticity. Hence we need not be surprised to learn that earthquake shocks have sometimes been heard twice; once through the solid rock, and so up to the ear, and again through the air which transmits the waves more slowly. Mr. Mallet made some interesting experiments on the velocity of transmission of waves due to a blow, through different substances.

In air the mean velocity of sound waves is 1,138 feet per second, but it varies with the atmospheric temperature and pressure—in water 4,692 feet, and in a bar of iron 11,040 feet per second. The movements of the ground



A, center of impulse; 1, 2, 3, 4, 5, 6, waves; A C B, A D B, angles of emergence.

during an earthquake are of a complicated character. In addition to the two kinds of movement which have generally been observed—namely, the upward shock and the long undulations, spreading in all directions, like marine waves—most authorities have added a rotating or gyratory movement. This causes a twisting of the ground, which has not only been seen but felt. Humboldt says that in Chile three great palm trees were seen to twist round one another like willow wands, after each had swept a small space round its trunk. Pinnacles of buildings have likewise been found to be twisted. The noise accompanying an earthquake often resembles that of an explosion. Since the velocity is affected by the hardness of the rocks, it follows that strata containing any hollows partly break and check the waves, as stakes driven into a shore break the force of sea waves in a storm. Hence we find that the early Greeks and Romans dug wells to fortify some of their cities, and prevent their complete destruction. In South America the natives have long ago adopted the same plan. Springs and natural underground passages for this reason afford considerable protection to cities which are liable to be visited by earthquakes.

Much has of late years been learned regarding seismic disturbances by taking observations which give the direction of the wave or waves, its velocity (obtained from the exact time at which it reached different places), and the "angle of emergence" as previously explained. The results are mapped out, and thus an "earthquake chart" is made, somewhat resembling the "weather charts" published daily in the *Times* newspaper. This done, it is invariably found that the greatest destruction is effected directly over the "center of impulse," and that the waves run roughly in circles or in ellipses from such a central spot. But the shapes as mapped out are often very irregular. This will be due to the nature of the surface of the ground and of the rocks below. It appears that in mountainous countries, like Switzerland and the Pyrenees, the great undulations are propagated in the direction of the valleys. In striking against the tilted strata at the bases of mountain masses they behave like waves of a river which dash against a bank, breaking up and changing their courses, and running along at the foot of the heights in the same direction as the stream of the valley. Earthquakes, though violent in their effects, are fortunately of very short duration. The great Calabrian earthquake lasted barely ten seconds!

We must now pass on to our second question, and consider the *effects* of earthquakes. First, they make many noises, variously described as resembling explosions of mines, distant artillery, peals of thunder, roar of cataracts, etc. Sometimes the shocks are felt before they are heard. Take the famous Lisbon earthquake of 1755. Towns in Portugal were overthrown, and places even in Morocco suffered considerable damage. The undulations extended over one-twelfth of the earth's surface! Thousands of persons were killed in Lisbon, and the sea was greatly disturbed. In England lakes and pools oscillated to and fro like water in a basin suddenly tilted. Even Iceland was affected. The sea rose in a great wave round the coasts of Britain, and ten hours after the sea round the West Indies was greatly disturbed! Shocks occurred for some months afterward.

Sometimes, as at Jamaica in 1692, the sea wave does more damage than the land wave. At Port Royal 2,500 houses were covered with water to a depth of 33 feet. It is interesting to note the behavior of animals before an earthquake. They seem to be able to detect slight tremors of the ground which we ourselves do not notice, and which precede earthquakes. Rats and mice leave their holes. The ground is frequently rent asunder, and sometimes permanent changes of level take place.

But it is not of the effects of seismic disturbances that we wish now to speak; they are well known and have been repeatedly described. Their nature and origin, though less clearly understood, afford more interesting matter for a brief paper such as the present. Let us, therefore, pass on at once to consider our third question: How earthquakes are caused. It has been shown in Switzerland that they are more frequent at night than during the daytime; and during winter than during summer. Facts of this nature seem to indicate that the contraction of rock masses, due to a lowering of temperature, such as absence of sunlight would involve, is intimately connected with whatever causes are at work in the earth's crust to produce earthquakes. Such contraction might produce dislocations in the rocks, and these would set up vibrations.

Again, by burying charges of gunpowder and gun cotton, and exploding them, Prof. Milne has succeeded in producing, on a small scale, phenomena closely resembling seismic disturbances. Experiments of this nature lead to the conclusion that some sudden blow, or impact, is the most frequent cause of earthquakes. But we must be careful not to assume that only one cause exists, and that all earthquakes are due to the same cause. Evidently this is not the case. During volcanic eruptions, and also previous to an eruption, the ground trembles and rumblings are heard, as of earthquakes. In Switzerland avalanches of snow in slipping down a mountain side cause slight earth tremors. The occasional falling down of great masses of rock produces similar effects.

The distribution of earthquakes helps to throw light on this difficult and, as yet, rather obscure subject. Thus they are found to be more frequent in mountainous regions than in flat, low countries. They have a connection also with volcanic regions, but rather an indirect than a direct one; for it is clear that earthquakes in general are not due to volcanoes or volcanic phenomena. Some geologists wrongly considered that all earthquakes were to be regarded as incomplete or unsuccessful attempts to establish a volcano. In other words, they are not caused by the struggles and efforts at escape made by superheated steam retained at high pressure below the surface of the earth. Steam undoubtedly is the power chiefly concerned in the production of volcanoes and of volcanic phenomena. But although earthquakes are concomitants of volcanic action, they are not to be attributed generally to the same causes.

Volcanoes are associated with great mountain chains, because it is only along these lines of weakness in the earth's crust—where the strata has been contorted, crumpled, folded, and cracked, over and over again, on a stupendous scale—that the masses of heated rock below the surface, charged as they are with superheated steam at enormous pressure, can find relief and come up to the surface.

By burying telephones and microphones in the earth, it has been found that slight noises and tremors which would otherwise never be noticed—unless by animals—can be detected. Transient shiverings of the earth's crust are thus found to be very frequent. Even in Britain we have a soil subject to storms of microscopic earthquakes which in other countries would be the forerunners of actual earthquakes. Wherever these little earthquakes occur the earth sends forth a medley of confused sounds—crackings and snappings—probably caused by the rocks creeping toward relief from the strains which urge them to change their position. Thus we begin to realize that the world is quivering like a mass of jelly!

It is hardly too much to say that this method of observation has enabled us in part to perceive the constant working of the great telluric machinery which continually builds our lands. Between these tiny movements and those which cause ordinary earthquakes there is only a difference of degree. They are essentially of the same nature. By means of delicate spirit levels, the bubbles of which move very easily, certain other movements, called "earth pulsations," have been detected by Prof. Milne. All these phenomena must be taken into account if we wish to find a satisfactory explanation.

Mr. Mallet submitted for consideration the following possible causes: 1. The sudden formation of steam by water coming in contact with highly-heated rock. 2. The escape of steam at a high pressure through fissures in the rocks and its condensation on reaching the sea. 3. Volcanic explosions. 4. Great fractures and dislocations in the earth's crust, suddenly produced by pressure or contraction in any direction. The first three of these suggestions are not sufficient to account for earthquakes which occur outside volcanic regions; the last one seems to supply what is wanted, namely, an explanation which connects earthquake phenomena with those movements of the crust of the earth which raise our continents, elevate our mountain chains, and afford means of escape for highly-heated rocky matter and associated steam from those deeply buried regions where the internal and external portions of the earth react upon each other.

In mountain building and the folding of strata we may look for the main cause of earthquakes. It is titanic work, and must necessarily involve innumerable snappings and much slipping of rocks past each other. Probably the slipping movements—the existence of which is abundantly proved by the numerous "faults" so familiar to geologists—took place gradually, that is, only a few inches at one time; so that a single fracture may have given rise to hundreds, or even thousands, of earthquakes. There is in mountain building a chance for many slight shocks with but a small amount of motion. In the formation of such folds as those composing Mont Blanc the tremors may have been numbered by the million. If earthquakes are associated with the raising up of mountains, who shall say that they are of no use?—*Knowledge.*

THE GOLD FIELDS OF MAINE.

Far up in the mountain-ribbed, lake-spangled borderlands of Maine, New Hampshire and Canada are streams whose sands are rich in that yellow metal for which men have toiled and fought since the earliest recorded times.

Gold has recently been "panned" from the gravel in scores of streams in the northern portions of Franklin and Oxford Counties, Me., while over in Coos County, N. H., mines have been operated for many years. But the mines now being worked in Byron, Oxford County, Me., are especially worthy of attention.

Here indeed is gold. Gold in the dirt, in the sand, in the gravel and in the ledges; gold which may be obtained by the veriest novice in mining by use of pick, pan and shovel.

The streams are rich with it, and the mountains must be full of it. For many years it has been known that gold exists in considerable quantities on the shores of Sandy River in Franklin County.

This county lies on the east of Oxford County. Branches of Sandy River rise in the same hills as do the sources of Swift River, and flow eastward and southward until the waters of the main stream (Sandy River), after flowing across Franklin County, enter the Kennebec River in the town of Starks, Somerset County.

The east branch of Swift River, rising less than a mile (but, of course, on the opposite slope) from the sources of the brooks which carry grains of gold to the Sandy River, flows westerly and northerly to the main stream of Swift River, whose waters finally mingle with those of the Androscoggin in the town of Mexico, its entire course being in Oxford County.

That there is gold in considerable quantities on the shores of Sandy River and in the sands of Swift River and its eastern branch would seem to be conclusive proof that somewhere on the mountain whose slopes form the common source of the streams named there exists quartz rich in the precious metal.

But before any attempt is made to work, or, rather, to locate definitely the source of the gold now being taken from the placers, those on Swift River and its eastern branch are to be thoroughly worked.

Already from six to ten thousand dollars have been washed from these placers, but until the past summer only the rudest methods have been employed. The gold obtained is said to be exceptionally pure, being one thousand fine and selling for nineteen dollars an ounce.

Many stories are told of the rush made by the people of the surrounding country to this Eldorado of the East, when, three years ago, it first became generally known that gold was to be had by picking it up from the river bank.

Certain persons carried away considerable quantities of gold, but, owing chiefly to ignorance of the proper methods to employ, the larger number secured but moderate returns for their labor. Then, too, very many of the first comers expected to find gold in large lumps and actually threw away more by weight of fine gold than they retained in coarse gold.

As one of these people said to the writer: "We found no 'nujjits,' and with our rude tools and with neither knowledge nor system we could make no more than a dollar or two a day. So we went back to farming."

As a matter of course, the stories told by such persons did much to deter others from making investigations. It may be that the interests of the few required that the many be discouraged.

The fact that three years after the many became disgusted with mining, practical miners are at work taking out considerable gold each season and confident of great returns in the near future is evidence of a very convincing kind.

These miners are not over-communicative. They are evidently perfectly willing, if indeed they are not exceedingly anxious, to be the sole occupants of this beautiful valley with all its developed and undeveloped mineral wealth.

They have many a smile for the artless rustic who prefers the hard, hot toil of the hayfield with its return of two and one and a half dollars a day to fairly shoveling wealth from the banks of the stream, over whose cool waters, clear and pure from the mountain springs, refreshing breezes are constantly blowing.

The company now conducting operations is constantly making fresh acquisitions of valuable territory, and offers no land for sale, its members having the confidence which comes with knowledge and experience.

This is the history of the first discovery: Ten years ago this month George A. Norcross, whose home was in Augusta, Me., but who had spent many years in the mines of California, was fishing for trout on the eastern branch of Swift River.

The practiced eyes of the miner were quick to detect the gold with which the sands of the stream abound. With a milk pan, borrowed from a nearby farmhouse, he was soon hard at work and before he returned to his Augusta home he was convinced of the importance of his discovery.

On reaching home he found that several of his most intimate friends were making up a party to go to the Black Hills. Believing his secret to be safe, Norcross was induced to become a member of this party.

Accordingly no use was made of the discovery on the east branch until the return of Norcross from the West in 1889.

With him came S. A. Wood, also an old miner familiar with the mines of California and the Black Hills. Winfield Scott Robinson, of Hartford, Oxford County, Me., a man of much intellectual ability, well educated and possessing considerable means, was told the secret which had been so carefully guarded for seven years.

Together with Norcross and Wood, Robinson went up the east branch late in 1889.

After prospecting several days and finding everywhere along the stream evidences of rich deposits of gold, Robinson purchased one hundred acres of land lying on both sides of the branch. In the following spring he bought the Peare farm of one hundred acres, also on the east branch.

Believing, for good reasons, that the lands on the main river were rich in gold, Mr. Robinson was impressed with the desirability of acquiring control of those lands.

His capital being limited, he interested Mr. J. N. Winslow, a wealthy resident of Portland, Me., who bought a share in the lands owned by Mr. Robinson, and the new company then (the autumn of 1891) purchased the Bancroft property on the main stream of Swift River at Coos Bridge. This land lies for a considerable distance on both sides of the river and is a rich placer.

It seems that many years ago, but within the memory of the "oldest inhabitant," there was a terrible avalanche or landslide from the side of the mountain which completely dammed the main stream of Swift River.

The waters, being thus checked, formed a very considerable lake. The pent-up waters finally acquired sufficient power to burst through the barrier, and, rushing down the valley, left death and destruction in their wake, many persons and domestic animals being drowned and much property destroyed.

As many times occurs in such cases, the river made for itself a new bed, and the old bed was gradually filled with stones, sand, gravel and mud. This old bed of the stream is now being uncovered by workmen in the employ of the company.

It is a placer averaging seven and one-half feet to bed rock. The top soil to the grass roots is showing much fine gold, while the packed gravel (next to the bed rock), averaging eighteen inches in depth, together with bed rock crevices, is proving very rich in coarse gold.

A dam, designated in these parts a "bush," or a "beaver dam," because constructed in the same manner as beavers make their dams, has been built diagonally across the main stream about one-fourth of a mile above Coos Bridge.

By means of this dam and the requisite sluices a considerable portion of the stream has been diverted into the old river bed and is being used to wash away the first six feet in depth of the placer, at an expense of less than four cents per cubic yard. This operation is known among miners as ground sluicing.

It settles the fine gold to the bottom on to the hard gravel, which will afterward be taken up with pick and shovel and run through the sluices in the original way.

In the piece now being worked, about six thousand cubic yards will be removed by the action of the water, after which the remaining two thousand cubic yards will be taken up with pick and shovel and run through the sluices.

Just after operations were begun last March, Norcross died. His was probably the first miner's funeral in Maine.

Four of his old companions, miners, bore his body to a grave in the little cemetery at "Gum Corner," in Byron, near the golden shores of the stream which he made famous, and on whose banks he lived, worked and died.

His old companion, S. A. Wood, big, brawny, rough in appearance, yet a thorough master of his business, continues in the employ of the company. One is reminded forcibly of the pictures of the early Californians as Wood swings a pick or handles a shovel. He is indeed one of Bret Harte's characters set down here among the mountains of Maine.

"It is now," said Mr. Robinson, "only a question of 'sand.' I found at the outset that the people of this vicinity could not be sufficiently interested to bring success to the undertaking. Capital must come from a distance. As usual the people of our county preferred to let their money go to some far-off Western investment rather than to allow it to develop the natural resources of our own section. The only man I found with sufficient wealth and grit and energy to put much money into the business was Mr. Winslow. We know that rich returns can be secured by putting men at work wheeling placer dirt to the river and washing out the gold, but we propose to let the river do the work. In a very short time, with the river doing most of the work, we shall take out large quantities of gold."

As a disinterested stranger, the writer is decidedly of the opinion. When requested to do so, Mr. Robinson "panned" a shovelful of the packed gravel.

This operation consists of first washing out the mud, next the fine river sand, cobble stones, etc., then the ruby sand, leaving the black sand mixed with gold in the bottom of the pan.

The pan is shallow, of steel, and holds about a shovelful. The motion is a peculiar rotary movement with the pan under water. The writer now has in his possession the result of panning a shovelful of gravel.

In a tablespoonful of black sand are probably more than a hundred "colors" and several good-sized grains of gold, one being about an eighth of an inch in length and of considerable thickness. This result was obtained from gravel taken at random from the placer on the main river.

A singular thing about the gold obtained here is the form of the grain, certain forms being peculiar to certain localities. This is taken as evidence that the gold has not been carried far from its source.

As a matter of fact, Swift River is less than forty miles in length. Up on the east branch the grains are in the form of rectangular prisms.

Further down the branch the form is wedgelike, being thick at one end and thin at the other.

Below the mouth of the branch and on the main stream, but above the Coos Bridge, the form is like that of a beech nut, while still further down the main stream and below the Coos Bridge the particles are oat-shaped, being thick in the middle and pointed at both ends.

The writer was told that, on the day before he examined the works, an old man who many years ago worked in the mines of Australia came up the river from Rumford Falls. With him came another man who brought shovel, pick and pan.

They asked permission to test the richness of the placer, and on being told to go ahead they started in for a day's mining.

The young man handled the shovel and the old man "panned." As the result of their day's work one man said they carried away more than an ounce of gold, and both admitted that they had more than twenty dollars' worth.

While examining the peculiar dam previously referred to, Mr. Robinson remarked that a considerable sum of money might be realized from the dirt used in its construction, and at once answered a look of surprise and incredulity by taking a shovelful of dirt from the dam and using the shovel as a pan he washed out half a hundred good "colors," thus proving conclusively that not only the packed gravel, but the top soil and the river sand are rich in the precious metal.

That lead and silver have been found in these mountains is a fact known to many.

Richard B. MacAlister of Andover, now nearly 70 years of age, recently gave the following account of one discovery of the metals named of which little has been said and less written.

In 1832 three men, named Dustan (MacAlister's great-uncle), Bean and Leavitt, the latter two living in Newry, were hunting moose about C pond in Andover North Surplus.

Dustan alone having succeeded in killing a moose, the other men agreed to help him carry the meat to Andover.

Late in the afternoon they packed the meat and started over the mountain. While still on the mountain, there being left a few minutes of daylight, they came upon a huge birch tree which had been blown over by the wind.

The roots of the tree had stripped the underlying ledge bare of earth, and Dustan, noticing a peculiar seam in the rock, threw down his load and with his hatchet hacked out a piece of metal.

Looking over to where his companions were resting on the other side of a ravine, he called out: "See here, boys, we can get all the lead we need to kill moose with right here!"

Continuing their journey they left the mountain, coming out into the old road connecting Andover and Upton at a spot near the "Old Maids' Pool," a pond through which flows the west branch of Ellis River.

A few weeks later Dustan went to Pennsylvania. Passing through Boston he offered for sale the piece of metal previously referred to.

Much to his surprise he was told that the lead was rich in silver, and finally he accepted $7.50 for his specimen.

Returning to Andover the next year, assisted by Bean and Leavitt, he searched for the overturned birch tree. They found many such trees, but not the one which marked the spot from which the ore had been cut the previous autumn. For three years Dustan passed a large part of his time in hunting for the lost mine. He failed to find it, and others who have sought the spot have done so in vain.

Mr. MacAlister also said it was a well known fact among the early settlers of this region (the town was first settled by white men in 1792) that the Indians who lived in this vicinity obtained lead from the mountain crossed by Dustan and his companions.

It was observed, too, that an Indian had left Andover Corner on several occasions, and, after being away about four hours, had returned with large pieces of what seemed to be almost pure lead.

From this it was inferred that a mine existed less than two hours' journey from the village. The Indians all seemed to know where to go for lead and not one could be induced to reveal the secret.

Certain it is that there were many persons who saw lead in its native state which was brought from a mountain west of Andover (presumably Wyman mountain) and who believed implicitly the account given by Dustan, Bean, Leavitt and different Indians, one of whom was the famous Moll Lockett.

If these accounts be true, in those Maine mountains there awaits some lucky discoverer a fortune as great as that of Monte Cristo.—*Mineralogists' Monthly.*

WILL THE COMING WOMAN LOSE HER HAIR?

By Miss E. F. Andrews.

I believe biologists are pretty well agreed that, if the present course of human evolution continues unchecked, the coming man is in serious danger of evolving into a bald-headed animal. What is to be the fate of the coming woman in this respect no one, as yet, has been bold enough to prophesy, though I think it may be safely assumed, for reasons presently to be given, that unless the æsthetic instincts of man should undergo a radical change, she will not only retain her "crowning" beauty unimpaired, but in augmented abundance and splendor.

Notwithstanding the gloomy predictions as to the "bald-headed and toothless future" (see *Popular Science Monthly*, October, 1886) in store for the human race, I have been more and more impressed, as the result of my own observations, with the almost complete immunity of my own sex from the results of those influences which are said to be operating so disastrously upon the personal attractiveness of the other. I have never seen a case of complete baldness among women of any age; partial baldness is rare, even among sexagenarians, while the large proportion of luxuriant suits of hair to be found among young women and girls would seem to indicate pretty clearly that, if baldness is to be a characteristic of the coming man, it will be one of those sexually limited variations, like hairy chins and guttural voices, that will not apply to the other sex.

It may be argued that the superior advantages possessed by women for concealing defects of this kind will prevent reliable observations being made in their case; but there are few women who do not know false hair from genuine when they see it, no matter how artistically arranged, and if any woman under sixty is afflicted with baldness it is pretty safe to assume that the other women of her acquaintance will know it. At all events, there are none of us, probably, who do not know the truth so far as our own mothers and grandmothers are concerned, and a simple comparison of their soft and often abundant gray tresses with the shiny pates of their spouses will be sufficient to convince most people that men, as a rule, have a practical monopoly of baldness.

And yet, most of the causes commonly assigned as conducive to this defect are as active among women as among men. They torture their hair with curling irons and papers and hairpins to a degree that no man would tolerate for an instant; they deaden and discolor it with all kinds of injurious washes; they rear upon the top of their heads structures as heating and uncomfortable as a stovepipe hat, or hang upon the back of them appendages of such size and weight as

to strain every hair at the root, and produce continuous headaches; and while their headgear may not be of quite so preposterous a shape as man's, they wear it much more constantly, since they sit with their heads covered in all public places, while he as a rule wears his hat only out of doors. Then, too, women, as a general thing, enjoy much less vigorous health than men, eat less nourishing food—pickles and candy often constituting a large part of their diet—are more frequently sufferers from headaches, deficient circulation, general debility, and Heaven only knows what not; and yet, with all this, the sorriest specimens of the sex, physically, often luxuriate in the most abundant suits of hair.

Now, why should one sex enjoy such comparative immunity from the results of practices that are producing such disastrous effects upon the personal appearance of the other? The answer, I take it, is to be found in a cause which Mr. Darwin claims to have been the chief factor in all cases where the purely ornamental qualities of a species are concerned—sexual selection. While women, under the pressure of public sentiment against "old maids," and the more urgent pressure of material necessities, will as a general thing marry anybody they think likely to give them a support, regardless of personal defects or attractions, men are more fastidious, and it goes without saying that a bald-headed woman would stand little chance, to use Mr. Darwin's argument, of leaving offspring to inherit her deficiencies. I have never known a woman who would make a bald head an invincible objection to a man who was eligible in other respects. Most of them are indifferent to that peculiarity, while some even like it; they think it looks intellectual, as more than one young woman, unsuspicious of the grave scientific motive underlying my frivolous "chaff," has assured me.

After occupying myself for some time with observations upon old and middle aged people, it occurred to me that the influence of this subtile factor, sexual selection, could best be determined by observations upon boys and girls under twenty, in whom, it is to be presumed, the influences of heredity have not yet been supplemented to any great extent by other causes. Accordingly, I had printed, and sent out to teachers and school superintendents, five hundred blanks, calling for statistics on the subject, with the request that they be filled and returned to me within the year. Of the five hundred, eighty-six were returned, and some of these contain discrepancies that render them practically worthless—a result, be it remarked in passing, which betrays a curious indifference on the part of teachers to matters of biological interest. The Atlantic City schools are the only ones from which I succeeded in obtaining anything like a full report, my efforts being ably seconded by their energetic and wide awake superintendent, Major W. F. Slaton.

Now, while the statistics at my disposal are too meager to warrant any definite conclusion, it is nevertheless a significant fact that out of a total of 1,196 males between the ages of ten and twenty, ten cases were reported as showing signs of baldness—that is, 0·0084, or over eight-tenths of one per cent.—while in a total of 1,374 females of the same age, but one single case is reported, or about 0·00073, a little over $\frac{1}{10}$ of one per cent. In other words, if the unsatisfactory statistics that I have been able to collect can be relied on, the proportion of baldness in boys and girls under twenty is about 80 to 7. As the majority of girls at the age under consideration wear their hair loose, or in simple "Marguerite" braids, so that there is little likelihood of deception, while unwholesome headgear or other individual practices can hardly, as yet, have had time to produce any material effect upon either sex, we may regard the differences indicated by the figures as practically due to the working of heredity alone. Now there is no apparent reason why girls should not inherit a tendency to baldness as well as boys, unless that tendency is checked by some other factor. Such a factor is sexual selection; for I presume it is hardly necessary to argue here that a bald-headed woman would not stand much chance of "survival" in the struggle for matrimonial honors. As men have always practically done the "selecting," and will probably continue to do so more and more as the conditions of modern life render the competition for husbands more severe, the woman's voice in the matter, when she has any, being limited to a simple negative, it is not likely that the state of baldness to which the human race is said to be tending will ever affect the feminine half of it. There are compensations in all things; and while the individual woman may sometimes murmur at the hard law of dependence which forces her too often to find in some measly little specimen of masculine humanity her only refuge from starvation, the sex in general has to thank the fastidiousness which their superior position cultivates in men for its exemption from a defect as destructive of beauty as of comfort. The time is, perhaps, not very far distant when, in the course of human evolution, a man with hair on his head will be as great an anomaly as a bearded woman, but as long as men love beauty and are won by personal charms, so long will women continue to rejoice in those abundant tresses of brown and gold that are one of the chief ornaments of their sex.—*Popular Science Monthly.*

THE CHEMICAL COMBINATION OF WATER AND AMMONIA.*

By THOMAS ANDRESON.

WHILE there are doubtless many present who are conversant with the component parts of water and ammonia, still there may be a few among us who have had neither time nor opportunity to give any consideration to the rudimentary chemical conditions presented by these all-important factors in the manufacture of ice. Should I in the course of my remarks dwell at length upon the chemical origin of the subject under consideration, I would ask of you not to regard it as an exhibition of erudition, but simply what I have designed it to be, a vehicle for the presentation, before this association, of a subject so pregnant with interest as to invite the most earnest thought and investigation, it being ever before us in our engine room practice. Only in this manner can we improve in the study of our chosen profession, and advance our association to that elevated position we so much desire. Having prefaced my paper with these few remarks, I will now proceed with the subject matter under consideration.

The purpose of chemistry is the investigation of the properties of simple and compound bodies, with their various combinations and compositions. By the chemical combination of two bodies, it will be observed that heat is often produced.

By elements are meant only those bodies which, up to the present, chemistry has been incapable of analyzing. In olden times there were but eight of these bodies known, viz.: Gold, silver, copper, iron, lead, quicksilver, tin, and sulphur. Slowly that number increased from the second and third centuries, so that in the eighteenth century we find it about doubled. This list was augmented by arsenic, bismuth, zinc, platinum, etc., until in 1774 when, with the discovery of oxygen and the subsequent researches in regard to the manner of combustion or oxidation, it gave birth to the science of chemistry.

To Priestley the world is indebted for the discovery of oxygen, although a year later Scheele's investigations led him also to prove its existence. In the light of this great contribution to science, the old time theories were overthrown by the famous French savant, Lavoisier, whose investigations in that direction presented it to the scientific world so that it has formed the basis of modern chemistry.

As I have before remarked, a body which is produced by a chemical combination contains fundamental properties, as its component parts bear evidence, which would have appeared incredible in the tenth century, although to-day it appears as a matter of course—a natural thing. Who would at that period have for a moment considered that silver-white quicksilver lurked in the purple-red cinnabar? Our ancestors would have smiled incredulously had any one advanced the idea that one of the most necessary of all necessities of life, water, was simply the combination of two gases, in certain proportions. Who, in the tenth century, would not have treated with ridicule a theory that the much-coveted and precious stone, the diamond, was only crystallized coal, which at certain temperatures could be burned.

Water, as it appears in nature, we can consider as a mechanical combination of molecules, of water and air (explained by illustration), and these properties will demonstrate the reason of the great evaporation of water upon the firing up of steam boilers, in which the individual molecules of the water expand by being warmed and disappear at length in the air.

The reverse is apparent in the condensation of steam when air is again a factor. It is not a long while ago that I was compelled to hear it often remarked by those who should have known better, that only by a direct contact of water and steam could a good vacuum be had, as by precipitation a smaller volume would ensue. This is, nevertheless, an error, because in its endeavor to return to its source, also in taking up the air and expelling the exhausted air, the vacuum will be apparent.

Hence, it is patent to every one who has charge of a large compound engine, with surface condensation, that by means of the independent circulation pump, and the direct entering of steam into the condenser, a vacuum is formed to relieve the back pressure from the piston of the engine.

Upon due investigation we learn that water becomes solid at a temperature slightly below 0° C., that being the temperature at which frozen water or ice melts; from 0° to 100° it is fluid, and taken at 100° becomes a gas. Its density is, independently of all other bodies, at its maximum at +4°. Water at that point increases in bulk by being either heated or cooled, which condition will remain until the water becomes solid.

As before remarked, water consists of two gases, viz., oxygen and hydrogen. If water is subjected to the two poles of a galvanic battery, there will be gathered on the poles two different and separate gases, one showing just double the volume of that which is on the other. These gases consist of one volume of oxygen and two volumes of hydrogen.

In case you fill a retort with two volumes of hydrogen and one volume of oxygen, and introduce an electric spark, the hydrogen will burn at the expense of the oxygen to two equivalents of chemically pure water. In the following illustration the variable action of the water by a change of temperature can be observed.

The curve represents the expansion of water from +4° by being either heated or cooled, and it will be observed that water at 0° and at +8° has the same density. This valuable property of water is an economy of nature of the greatest importance, as by this means, when water freezes in winter, an extended penetration of cold is checked and the formation of ice is in a measure impeded. When water chills from above then the colder layers will penetrate until a temperature of 4° C. is indicated. As a result of the action of greater cold the upper layers expand again in freezing, while the underneath layers, even in winter, will return to the temperature of +4°.

Water under 0° can be cooled off before freezing takes place. This can occur when its temperature is slowly varied, the conditions being very quiet by which a temperature of 10° C. was attained before freezing set in. A pump which was permitted to remain over-night with a closed stop cock contracted with the lowering of the temperature of the atmosphere and the water decreased in bulk as the temperature of the greatest density was reached; then the water suddenly froze and expanded; consequently, as the density of ice is but 0·94, that is, one cubic foot of ice weighs only 0·94 parts that of the same bulk of water, hence in freezing expansion takes place.

Now to return to the elements of water, we find that oxygen is a gas devoid of color, smell, or taste. It can be easiest generated by the heating of oxide of quicksilver. Oxygen is found in every portion of the realm of nature, it is most abundant of all the elements, comprising 88 per cent. of the weight of water, 75 per cent. of all the animal bodies, about 50 per cent. of the crust of the earth, and more than 20 per cent. of the air. Oxygen will combine with most simple bodies and the process is called combustion or oxidization and the products are known as oxides.

By combustion we understand the combination of a body with oxygen under such conditions as produce strong light and heat; all bodies which are produced by the combustion in air, giving light and heat, owe that state to the rapid combination of oxygen. For instance, if you were to plunge a glowing splinter of wood into a vessel filled with oxygen, it would burst into flame and burn with great brilliancy. In a similar manner oxygen acts upon the human system by means of the lungs. Certain parts of the body are oxidized, by which chemical combination the warmth produced will be recognized as the heat of the body.

Upon returning to the subject of hydrogen, we find that it is a gas which has also the properties of being devoid of color, smell, and taste. It is the lightest of all bodies, has a specific weight, air=1, of but 0·0692; hence, is nearly fourteen times as light as air. By reason of its low specific gravity it is frequently utilized for inflating balloons. While hydrogen will undergo combustion when in the presence of oxygen, it will not burn by itself. Hydrogen, when ignited in presence of oxygen, burns with a dim flame and the product is water.

Hydrogen can be produced by passing steam through a tube filled with iron wire and heated to bright redness; the steam will precipitate to its component parts; the oxygen will combine with the iron and the hydrogen will be liberated. Hydrogen is found in nearly all organic bodies, and its principal combination in the economy of nature is with oxygen, the indispensable necessity of all organisms.

Another combination of hydrogen which has caused ice machine engineers so many vexations and anxious moments is that of its combination with nitrogen to form ammonia. The condensation of three volumes of hydrogen and one volume of nitrogen into two volumes produces that body which is so valuable and important to us. Ammonia is a colorless and very pungent gas which greatly affects the eyes and breathing organs, causing, headache, and is also very poisonous. It is lighter than atmospheric air and is easily dissolved in water, the latter being capable of absorbing 725 times its volume of ammoniacal gas. In all cases of disassociation where these two gases, nitrogen and hydrogen, are released, ammonia is produced at the same time. It is formed by decay as well and by the distillation of bodies containing nitrogen.

I deeply regret that I am not in a position to bring before you at the present time further data in regard to the manufacture of commercial ammonia. It has never been my good fortune to visit an ammonia factory, and it is much to be desired by us all that some brother will, at some future meeting, give us a description of the manner of its manufacture for use in ice machines. The general idea that ammonia is combustible is decidedly wrong, as only in the air and in oxygen itself will ammonia burn with a yellow flame, as before mentioned. Ammonia is lighter than atmospheric air, and hence it is impossible to remove the air found in the system from the highest point in the condenser, without considerable loss of gas.

As, in my practice, I have found no beaten track, I am quite anxious to learn the views and experiences of my brother engineers. The many uses and demands for ammonia by mankind present themselves in a great many ways. We especially, as engineers, have to meet face to face the question of the evaporation of ammonia. A liquid which possesses the peculiarity of creating vapor necessitates in its evolution to vapor considerable warmth.

The heat of evaporation is not indicated by the thermometer, and hence is called absorbed or latent heat, in distinction to the liberated warmth to which the thermometer is sensitive. With water it is 536° C. or 996° F., with ether only 90°, and with ammonia 234°.

During the process of evaporation a fluid is necessary which will be compelled to draw on its own free warmth, in consequence of which the temperature will become lower, and as to every body whose temperature is lower than its surroundings heat will naturally flow from the outside with a great rapidity, notwithstanding the fact that it is necessary for the bodies which cause the evaporation to absorb latent heat, either direct or indirect; it is withdrawn and so causes the low temperature required. But to check the vaporizing fluid from being liberated, and with a view of using it over again, it is necessary to convey it back again in a liquid form and the thereby liberated latent heat to be absorbed by the cooler.

This manner of reconveying the vapor in a liquid form is the basis of two different ways of utilizing vapor. Either this is done with a pressure pump or in the manner that the vapor of steam is forced into a condenser, where it is subject to the action of cold water and by the power exercised by the pump is precipitated, or the vapor, by means of absorption, attains a density, so that a second fluidity is produced from which by chemical affinity the heat can be absorbed. By affinity or chemical relationship we are to understand that it is a peculiar power, the existence of which is only manifested by the direct general disturbance of the molecules.

Every gas follows a change of volume by means of compression or expansion according to the principles laid down by Mariotte. The volume of a given quantity of gas is in the inverse ratio to the pressure, the volumes and pressure being calculated from the absolute. We usually meet with these gases at a pressure of one atmosphere.

This fundamental principle holds good in practice for all gases. Nevertheless in the matter of compression there is another point to be taken into consideration, viz., the development of heat, and this appearance of heat is of the greatest importance. In the case of compression of gas, the mechanical effect will be warmth and the temperature will be higher.

Starting from the same initial temperature and pressure and in the same volume, various gases will not only show different temperatures, but a diversity of pressure as well. Should, for instance, a volume of atmospheric air subjected to a pressure of an atmosphere show 20°, so the temperature, when under a pressure of two atmospheres, would be 85°, and at four atmospheres would reach 163°. If you will allow compressed gas to expand again, and under less pressure, you will find the warmth on the outside decreasing and the cooling off will be in the same proportion to the increase in volume. As by compression a rise in the temperature is produced, so by expansion a fall of temperature is obtained.

Should a confined gas be first cooled off and then expanded, its temperature will fall and a low degree of

* Read before Linde Association, No. 38, Illinois, N. A. S. E.—*Stationary Engineer.*

heat will be reached. As an illustration: Air of 2, 3, and 4 atmospheres cooled to 30°, by the expansion of one atmosphere, the temperatures of 25°, 53°, and 70° C. below zero will be obtained. These basic principles, which will also apply to vapors of vaporizing fluids, relate in their application specially to the practice of ice machinery.

Several principles exist, particularly in regard to the mechanical theory of heat, which we will pass by, owing to the complicated nature of the calculations. I would like to mention incidentally that the basis of artificial cold production was first laid down scientifically and for practical use by Prof. Linde.

Theoretically, the study of thermo-dynamics shows that to produce a given quantity of heat a great deal of energy is necessary, when the cooling process of ice and refrigerating machines is produced by means of air, ether, ammonia, or other fluids. It is the quantity of heat which is absorbed and rendered latent in the production of a certain quantity of vapor from a given quantity of liquid that serves to hold the molecules of the gases from all fluids in the expanded conditions, but this quantity is not the same for all gases, but is proportional to the component elements of each gas. The greater the tension of the vapor, the lesser the number of heat units necessary to keep it in the proper condition, and the greater the amount of work it is capable of performing in the way of cooling.

According to Prof. Linde's calculations, to produce 100 lb. of ice from water at 40°, it is necessary to use: Air 740 cu. m., sulphuric ether 150 cu. m., and ammonia 5·6 cu. m. On the same conditions in regard to the application of these fluid substances the dimensions of the required machinery must be considered. In the process of compression, by reason of the least difficulties of construction, the compressing machines which use ammonia have had a rapid sale.

STAINING VEGETABLE TISSUES.*

It is found in practice that sections prepared for microscopical examination become much more intelligible, even to experienced workers, if they are suitably stained. By this is meant a process of differentiation of the tissue systems, based upon the employment of various dyestuffs. In many instances, too, the recognition of certain cell contents is rendered more certain. Squire divides such coloring agents into nuclear, plasmatic and specific stains. The first named are of value in proportion as they exhibit a selective affinity for the substance of nuclei, while leaving the ground substance comparatively uncolored. Such stains are, of course, only needed in dealing with fresh tissues, and there is little doubt that hæmatoxylin is the best for the purpose. There are many different formulas for its preparation, but it is both difficult and tedious to prepare satisfactorily by most of them. The formula for Ehrlich's ammoniated hæmatoxylin is free from these objections. Hæmatoxylin, 2 grammes, and ammonium carbonate, 0·4 gramme, are dissolved in proof spirit, 40 c. c., and exposed to the air in a shallow dish for twenty-four hours. The volume is then made up to 40 c. c. with proof spirit, which is warmed, if necessary, to dissolve any separated crystals. Ammonia alum, 2 grammes, dissolved in distilled water, 80 c. c., is then added; together with glycerin, 100 c. c., rectified spirit, 80 c. c., glacial acetic acid, 10 c. c. ("Methods and Formulæ," p. 24.) The solution is ready to be diluted for use straightway and does not deteriorate by keeping. Sections when stained with it are of a violet color, but this may readily be changed to blue by washing in an aqueous solution of sodium bicarbonate (⅛ grain in 1 oz.) As soon as the color is satisfactory the sections should be transferred to 70 per cent. alcohol; for if kept in water, the color is apt to fade. Over-staining may be remedied by the addition of one-tenth to half per cent. of strong hydrochloric acid to the alcohol and subsequent washing with the sodium bicarbonate solution already mentioned. Carmine answers the same purpose as hæmatoxylin, and may be used as an alternative, but does not leave nuclei so sharply defined. A useful preparation of it is Grenacher's alcoholic borax carmine, made by dissolving borax, 4 grammes, in distilled water, 100 c. c., adding carmine, 3 grammes, and heating gently; 100 c. c. of 70 per cent. alcohol is then added, and the solution filtered if necessary before use. The sections, after staining, are transferred to alcohol (70 per cent.) containing half to one per cent. of hydrochloric acid (sp. gr. 1·16).

Plasmatic stains color the tissue uniformly, and are used to color the ground for the sake of contrast, when nuclear and specific stains have been previously used. Alcohol must be removed from the sections by placing them for a minute in distilled water, after which they may be transferred to the plasmatic stain. To follow hæmatoxylin this may be water soluble eosin (1 grm. in 40 c. c. of s. v. r., and 160 c. c. aq. dest.), erythrosin (same strength as eosin), or orange (2 grm. in 20 c. c. of s. v. r., and 80 c. c. aq. dest.) After using carmine, picric acid (1 grm. in 100 c. c. of 70 per cent. alcohol) affords a suitable contrast. In each instance afterward wash with 90 per cent. alcohol. *Specific stains*, as their name implies, are used to distinguish certain elements only from the mass of tissue. Carmine, hæmatoxylin and most of the aniline dyes stain unaltered cellulose, while lignified tissue may be permanently stained with methyl green (0·25 grm. in 20 c. c. of s. v. r. and 80 c. c. aq. dest.) Squire's process for double staining stem and root sections containing cellulose and lignified tissue is to first rinse in distilled water, then place in methyl green solution for three or four minutes; again rinse in water, wash in 90 per cent. alcohol for five or ten minutes; place in Grenacher's alcoholic borax carmine for fifteen or twenty minutes; rinse quickly in water, and pass through 90 per cent. alcohol. Chlorzinc iodine† colors cellulose blue and lignin yellow or yellowish brown, the latter being also colored red with phoroglucin (1 grm. in 20 c. c. s. v. r., and 80 c. c. aq. dest.) and strong hydrochloric acid, and yellow with aniline chloride (2 grm. in 65 c. c. of s. v. r., 35 c. c. aq. dest., and 2 c. c. strong H Cl). Hoffmann's blue or eosin is specially useful for distinguishing sieve areas. Particulars of other specific stains and their uses may be found in Poulsen's "Botanical Micro-Chemistry." For permanent preparations of fresh vegetable tissues hæmatoxylin will be found the most useful single stain, since by controlling its action it is quite possible to differentiate all the constituents with it, each one displaying a distinct shade of blue, marking it off clearly from the rest. The best results in double staining or in dealing with dark colored drug sections, etc., can only be obtained by first bleaching (*Pharm. Journ.*, 3, xxii., 869), and then carefully removing all traces of the bleaching agent before applying the stains. In this case, of course, all cell contents are of necessity destroyed, and removed during the process of washing.

* *Pharm. Journal and Transactions*, 461.

† Schulze's solution: prepared by evaporating 100 c. c. liq. zinci chlor., B. P., to 70 c. c., and dissolving in it 10 grammes potassium iodide. Add 0·3 gramme iodine, and shake frequently until saturated. ("Methods and Formulæ," p. 55.)

The sirup of ipecac ought to be kept in every nursery. It is the medicine mothers should give while waiting for their physicians, when their children are attacked with croup or heavy "colds on the chest." In croup an emetic dose will be needed, and one teaspoonful should be given every ten minutes until the little patient vomits. In a severe cough, which is dry and hacking, for the purpose of loosening it, about five drops should be given a baby every two or three hours until a physician assumes the treatment.

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